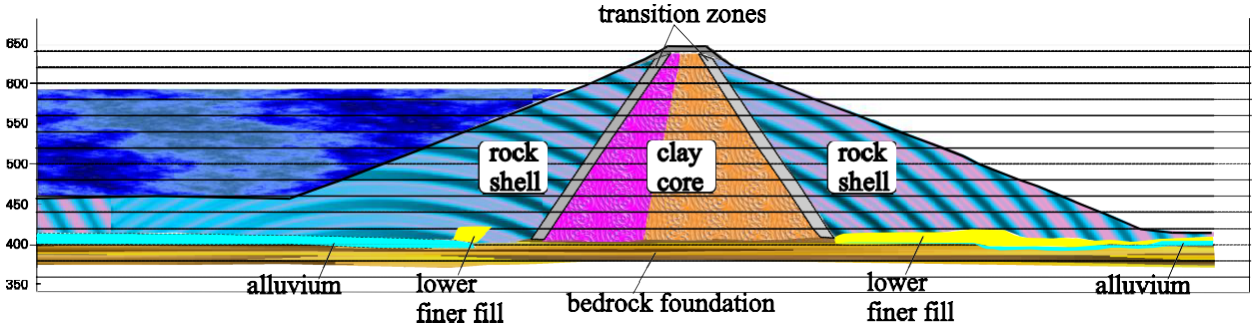
December 2011

2011 SURVEILLANCE REPORT
December 2010 through December 2011
LEROY ANDERSON DAM NO. 72-9
Santa Clara County



Santa Clara Valley Water District

Santa Clara Valley Water District

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December 30, 2011

Mr. David A. Gutierrez, Chief
Division of Safety of Dams
Department of Water Resources
1416 Ninth Street
P.O. Box 942836
Sacramento, CA 94236-0001

Subject: Leroy Anderson Dam, No. 72-9, Santa Clara County
December 2010 through December 2011
2011 Surveillance Report

Dear **Mr.** Gutierrez:

Please find enclosed two copies of our 2011 surveillance report for Leroy Anderson Dam covering the period from December 2010 to December 2011.

Our review of the surveillance data and our periodic safety inspections indicate that Anderson Dam and appurtenant structures appear to show normal response to their environment, aging process, and external events. Except for a third operating restriction mentioned below, there were no major incidents or changes at the dam during 2011. Except for a few instances during the period of this report when piezometer data excursions occurred outside of established action level limits for short periods of time, there were no surveillance instrumentation alarm conditions.

The Santa Clara Valley Water District (District) will continue with the current monitoring program and safety inspections and will keep DSOD informed of any significant changes pertaining to the surveillance or performance of Anderson Dam. During the current reporting period, there were no new activities at the site that would impact monitoring of this facility.

A new interim operating restriction was implemented for Anderson Reservoir that reduced the restriction from ~57 feet of total freeboard to ~45.5 feet. The restriction is monitored by District Operations and Planning Analysis Unit and supersedes the earlier 2010 restriction. Except for the new operating restriction at Anderson Reservoir, there are no substantive changes in dam or reservoir response compared to previous years.

In June 2011, the District resolved the power supply issues affecting the Automated Data Acquisition System (ADAS) that had been affecting piezometer (VWPs) and in-place inclinometer sensor (!Pis) data gathering at Anderson . The District is currently obtaining fairly continuous data readings from all VWPs and IPIs.

Please contact me at (408) 265-2607, extension 2736, if you have any questions.

Sincerely,

James M. Fiedler, P.E., D.WRE
Chief Operating Officer
Water Utilities Enterprise

Enclosures
cc/enc: F. Maitski, T. Dougherty, D. Hook, M. Mooers, B. Baker, S. Wu, J. Nelson, L. Fleming, Library (4)
cc: R. Jacobs, D. Hook, L. Lopez
jn:fd
1228c-l.docx

2011 SURVEILLANCE REPORT
December 2010 through December 2011
LEROY ANDERSON DAM NO. 72-9
Santa Clara County

Date of photo 10/10/06
Photo shows temporary drill rig access roads and 2 drill rigs on dam crest for DIP

Prepared for:

State of California
Department of Water Resources
Division of Safety of Dams
P.O. Box 942836
Sacramento, CA 95236

Prepared by:
Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118

December 2011

2011 SURVEILLANCE REPORT
December 2010 through December 2011
LEROY ANDERSON DAM NO. 72-9
Santa Clara County

The analysis and interpretation of the instn,mentation and other relevant data presented in this report has involved the application of certain graphical and statistical interpretive techniques common to the geosciences and earth dam engineering professions. The conclusions presented in this report were developed upon evaluating the performance of all instruments and other pertinent data during the specified period, and represent the professional judgment of its author. This report was published on December 30, 2011 .

Report prepared by:

PROFESSIONAL GEOLOGIST
JAMES LEWIS NELSON
No. 1463
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

James L. Nelson, C.E.G.
Senior Engineering Geologist
Dam Safety Program Unit

Quality Control/Quality Assurance

This report has been reviewed and approved for publication by the undersigned professional eng inee rs . attest and confirm that the report was prepared by the individual who signed the report under my immediate direction and supervision and that the conclusions and recommendations presented herein are reasonable and supported by District management.

Reviewed and approved by:

David E. Hook, P.E.
Engineering Unit Manager
Dam Safety Program Unit

Reviewed by:

Steven M. Wu, P.E., G.E.
Senior Engineer
Dam Safety Program Unit

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1.0 EXECUTIVE SUMMARY

This 2011 Surveillance Report summarizes the Santa Clara Valley Water District's (District) evaluation of Leroy Anderson Dam (Anderson Dam) No. 72-9 and reservoir located in southern Santa Clara County, California, for the surveillance period from December 1, 2010 through December 30, 2011 . Our review of the surveillance data and our periodic safety inspections indicate that Anderson Dam and appurtenant structures appear to show normal response to their environment, aging process, and external events. Except for a third operating restriction mentioned below, there were no major incidents or changes at the dam during 2011. During the period of this report, there were no surveillance instrumentation alarm conditions.

The District will continue with the current monitoring program and safety inspections and will keep DSOD informed of any significant changes pertaining to the surveillance or performance of Anderson Dam. During the current reporting period, there were no new activities at the site that would impact monitoring of this facility.

DSOD approved, with concurrence from FERC, a new interim operating restriction for Anderson Reservoir that reduced the restriction from ~57 feet of total freeboard to ~45.5 feet. The restriction is monitored by District Operations and Analysis Unit and supersedes the earlier 2010 restriction. Except for the new operating restriction at Anderson Reservoir, there are no substantive changes in dam or reservoir response compared to previous years.

2.0 INTRODUCTION

2.1 Scope and Purpose

The last surveillance report for Anderson Dam was published January 2011 (Nelson, 2011). The focus of this 2011 annual surveillance report is to review the data for overall accuracy and to make assessments of general data trends. If any significant geotechnical or operational events have occurred (i.e., earthquakes, sustained elevated reservoir levels, significant operational or maintenance changes, or dam instrumentation/monitoring changes), these are addressed to the appropriate level in this report. This report provides historic data plots covering the last 10 years (since ~ 2001) or since the installation date if less than ten years of instrument readings. The reader is referred to previous reports for earlier observations.

This report addresses comments regarding surveillance reporting from the last field inspection reports for Leroy Anderson Dam facilities by DSOD titled “Inspection of Dam and Reservoir in Certified Status” dated March 8, 2011 (DSOD, 2011) for a DSOD inspection of that facility. The DSOD report summarized findings of an annual DSOD inspection that occurred on February 14, 2011. According to their latest inspection report and review of the 2010 surveillance report (Nelson, 2011), DSOD stated that “The available instrumentation data indicates the dam is performing satisfactorily. The current instrumentation network is adequate and no additional instrumentation is deemed necessary at this time.

2.2 Recent Safety and Other Studies

2.2.1 Seismic Stability Evaluation SSE1A -

In July 2011, AMEC completed the seismic stability evaluation (SSE1A) of Anderson Dam

(AMEC, 2011a), which confirmed that potentially liquefiable soils are present under the upstream and downstream shells. Copies of the Final Seismic Stability Evaluation Report were sent to DSOD in July 2011.

2.3.2 2011 (Sixth) Part 12D Safety Inspection and Report to FERC

In August 2011 the District completed and submitted the 2011 (Sixth) Part 12D Safety Inspection Report for Anderson Dam (Geosyntec, 2011a) as required by the Federal Energy Regulatory Commission (FERC). This work includes review and update of the 2007 Potential Failure Mode Analysis along with an update of the Supporting Technical Information Document (STID) (Geosyntec, 2011b). Copies of these reports were sent to DSOD and FERC in August 2011.

2.3.3 Anderson Dam Seismic Retrofit Project Planning Consultant

In November 2011 the District selected a planning consultant team for the Anderson Dam Seismic Retrofit Project consisting of HDR as the primary consultant with AMEC, Jacobs, and Horizon as sub-consultants. The contract is planned for Board of Directors approval in February, 2012.

2.3.4 Tailwater Alarm System

In 2011, at the request of FERC, the District began developing procedures for a Downstream Tailwater System to improve detection time for Time-Sensitive Emergency Action Plans (EAPs) downstream of Anderson Dam. Existing downstream gauge station 82, located ~1 mile downstream on Coyote Creek, was upgraded to serve as a tailwater alarm system. The District is currently refining suitable Action Levels and procedures for directly responding to tailwater alarms.

The following describes a likely procedure for alarm notification. The District's ALERT system has a dual notification capability to the On-Call Hydrographer staff for redundancy. The system pages and starts an autodialer that contacts the On-Call Hydrographer, who then notifies Dam Safety Program Unit staff with a page, phone call and/or e-mail. The On-Call Hydrographer verifies that the alarm is real and contacts staff with the results, and then resets the alarm.

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3.0 BACKGROUND INFORMATION AND METHODOLOGY

3.1 General Surveillance

Figure 1 shows the locations of crest monuments, spillway training wall monuments, pneumatic, vibrating wire and open well piezometers, accelerometers, and the spillway underdrain weirs at Anderson Dam. Transverse and longitudinal sections are shown in Figures 2 through 4. Specifically, Figure 2 presents a transverse cross section A-A' through a minor section of the left abutment of the dam. Figure 3 presents cross section B-B' near the maximum section of the dam. Figure 4 presents a longitudinal section C-C' along the crest. The sections show vibrating wire piezometers, pneumatic piezometers, open well piezometers OW-1, OW-2 and OW-3 (the latter two installed during the current Seismic Stability Evaluation, SSE1A).

Table 1 (page 8) presents a list of locations for each vibrating wire piezometer (VWP) and open well piezometers OW-2 and OW-3. Table 2 (page 9) summarizes piezometric surface elevations (PSE in ft) of pneumatic piezometers and newer open well piezometers, and Table 3 (page 14) summarizes spillway underdrain flow. Tables 4 and 5 (pages 17 and 18, respectively) summarize survey data from the dam crest and spillway training walls. Table 6 (page 19) presents a list of pertinent data of each in-place inclinometer sensor (IPIs). All surveillance data are also shown graphically on Figures 5 through 18, and discussed later in the report.

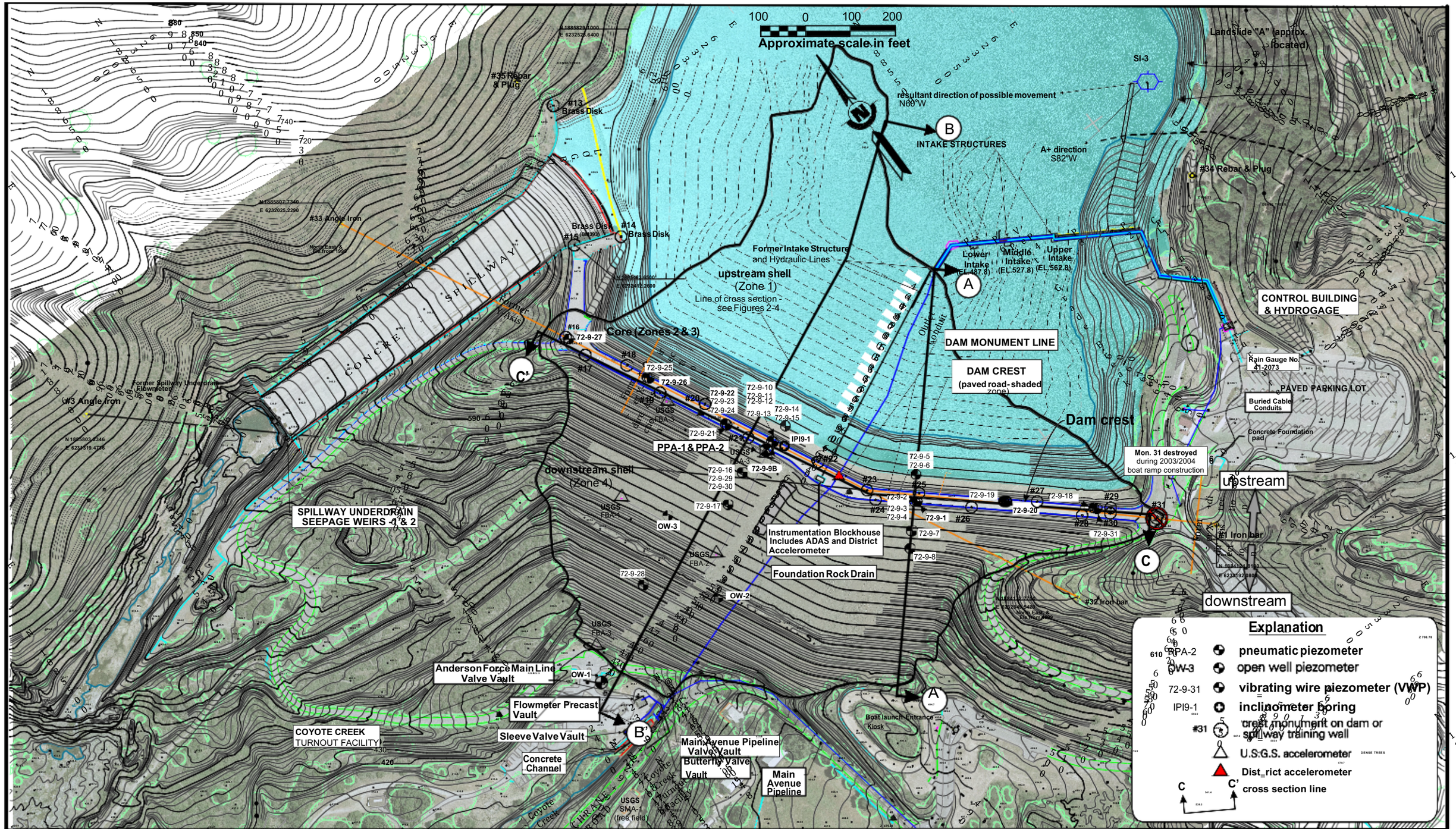
During the time period covered by this report, the District monitored 2 pneumatic piezometers in the dam, 2 spillway underdrain seepage weirs, 15 dam crest survey monuments, 2 spillway training wall survey monuments, 3 open well piezometers, 31 vibrating wire piezometers and 6 in-place inclinometer sensors.

All new data covered in this report is presented in tabular form, and plotted to facilitate review. For the period of this report, data were collected annually for survey monuments and monthly for pneumatic piezometers, open wells, and underdrain weirs. Data were collected from the vibrating wire piezometers at various intervals as summarized in *Section 4.0 Surveillance Information*. Crest monuments were surveyed at the times indicated (typically near the end of every year).

All elevation data presented in this report have been adjusted for the current datum used by the District Dam Safety Program, which is the North American Vertical Datum (NAVD) 1988, which is 2.80 feet higher than the old datum, National Geodetic Vertical Datum (NGVD) 1929, at this location.

Since December 2008, data from vibrating wire piezometers and in-place inclinometers are collected by an Automated Data Acquisition System (ADAS). Since corrective maintenance was performed in June 2011, the District has been able to collect viable in-place inclinometer data. Prior to that time the District had been collecting manual readings of the IPIs and several VWPs since September 16, 2008, because ADAS was not collecting viable IPIs data.

During the period of this report, there have been minimal changes in reservoir elevations (total excursion of ~26 feet) and relatively low reservoir elevations (between ~25 and 51 feet below spillway lip). These are similar to values reported in 2010 (Nelson, 2010). The maximum reservoir elevation achieved in March 29, 2011 of el. 602.4 ft was similar to the maximum reservoir elevation of 602 ft in 2009 and 2010. In this report, vibrating wire piezometer plots are grouped and presented as standard piezometer and reservoir plots versus time.



Reference information and notes:

1) This map is a compilation of aerial mapping, survey field data, and digitized construction maps. Maximum error could be **± one foot vertical and horizontal; error greater for upstream topographic lines (see note 7)**
2) Grid is based on California Coordinate System, Zone III, NAD 83.
3) Elevations based on N.G.S. Vertical datum, NAVD 88. The DE between NGVD 29 and NAVD 88 is 2.80'
4) Photogrammetric mapping: Transvision, Photo date 12/11/97; color photo date 2006
5) file W:\geology\DAMS\Historic Dam Geology\anderson\ANDHistgeo.cdr
6) selected 1987-88 dam raise values in feet shown in red
7) upstream dam topography (dashed lines) from as-built 1988 "Leroy Anderson Dam Intake Structure Modification, Sheet 2, scale 1"=100', dated 1-8-88, from 10-7-87 aerial photography, modified to NGVD 88

DATE	12/08/11
DESIGN	JLN
DRAWN	JLN
CHECKED	DEH

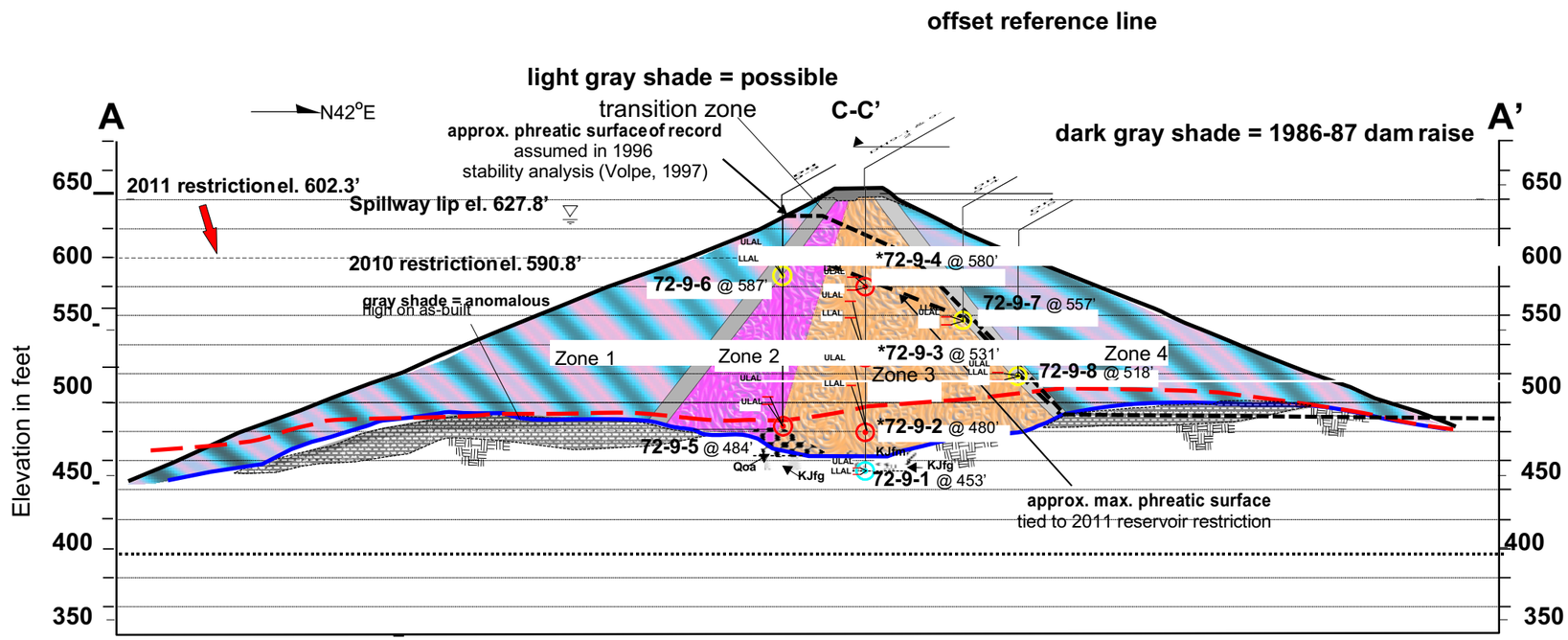
Santa Clara Valley Water District

Topographic Map
Surveillance Instrumentation
Leroy Anderson Dam

SCALE 1" = 200'

FIGURE 1

Section A-A' (sta. 6+00)



Explanation

boring number

72-9-8

vibrating wire piezometer

excavated topography (as-built) adjusted to DIP drill hole logs

excavated topography (as-built) adjusted 2.8' for new datum

original topography adjusted 2.8' for new datum

Bedrock & Soil Foundation Units from DIP/SSE1B

Qoa/Qc = Quaternary older alluvium and/or colluvium

QTsc = Plio-Pleistocene Santa Clara Fm

KJfm = Franciscan Complex melange

KJfg = Franciscan Complex greenstone

red = embankment
yellow = transition zone
green = colluvium/alluvium
blue = foundation

* = installed using grout-in methods (see text)
all other piezometers installed using sand-pack methods

Action Levels

tied to 2011 res. restricted elev. 602.3 ft

Range of acceptable piezo surface

ULAL = upper limit action level

LLAL = lower limit action level

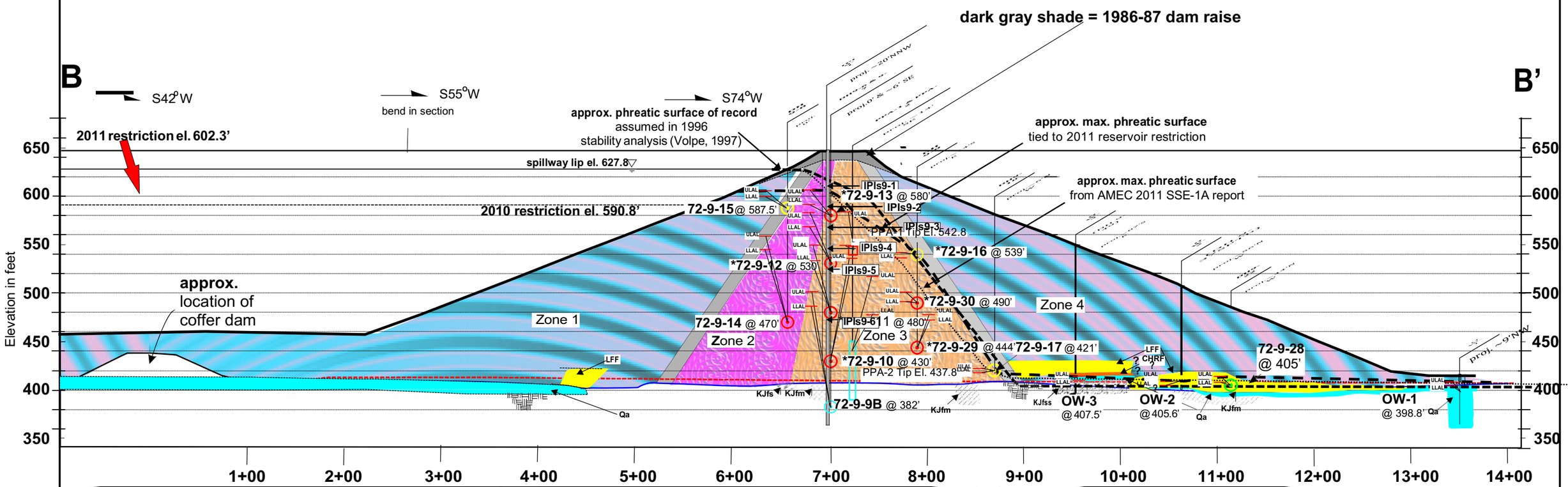
*72-9-8 @ 510'

Notes:
1) File: W:\geology\dams\Historic_Dam_Geology\Anderson\andxsecA-A'rev.cdr
2) basis of elevations is NAVD 1988-elevations are 2.80' higher than NGVD 1929

DATE 12/08/11	Santa Clara Valley Water District	**Cross Section A-A'**	SCALE 1"=100'
DESIGN JLN			FIGURE
DRAWN JLN		Leroy Anderson Dam	2
CHECKED DEH			

Section B-B' (transverse max section alongthalweg)

C-C'



Explanation

boring number — 72-9-28 ⊙ vibrating wire piezometer

72-9-ASI-2 — automated slope indicator

DH9-20 — geophysical

DH9-20 — lithologic logging

excavated topography (as-built) corrected 2.8' for new datum

excavated topography (as-built) adjusted to DIP drill hole logs

original topography corrected 2.8' for new datum

* = installed using grout-in methods (see text)
all other piezometers installed using sand-pack methods

Embankment/Fill Units from DIP/SSE1A

- Zones 1 (downstream) and 4 (upstream): rockfill
- Transition Zones, downstream and upstream
- Zone 2 upstream core
- Zone 3 downstream core
- Construction haul road fill (CHRF)
- Lower Finer Fill (LLF), downstream and upstream

Bedrock and Foundation Soil Units from DIP/SSE1A

- Qa/Qc = Quaternary alluvium and/or colluvium
- KJfm = Franciscan Complex melange
- KJfss = Franciscan Complex graywacke sandstone

red = embankment
yellow = transition zone
green = colluvium/alluvium
blue = foundation

Action Levels

tied to 2011 res. restricted elev. 602.3 ft

Range of acceptable piezo surface

ULAL = upper limit action level

LLAL = lower limit action level

*72-9-28 @ 405'

Notes:

1) File: W:\geology\dams\historic dam geology\anderson\andxsecB-B'rev.cdr
2) basis of elevations is NAVD 1988-elevations are 2.80' higher than NGVD 1929
3) Downstream and upstream foundation materials taken from AMEC (2010 draft)

DATE	12/08/11
DESIGN	JLN
DRAWN	JLN
CHECKED	DEH

Santa Clara Valley Water District

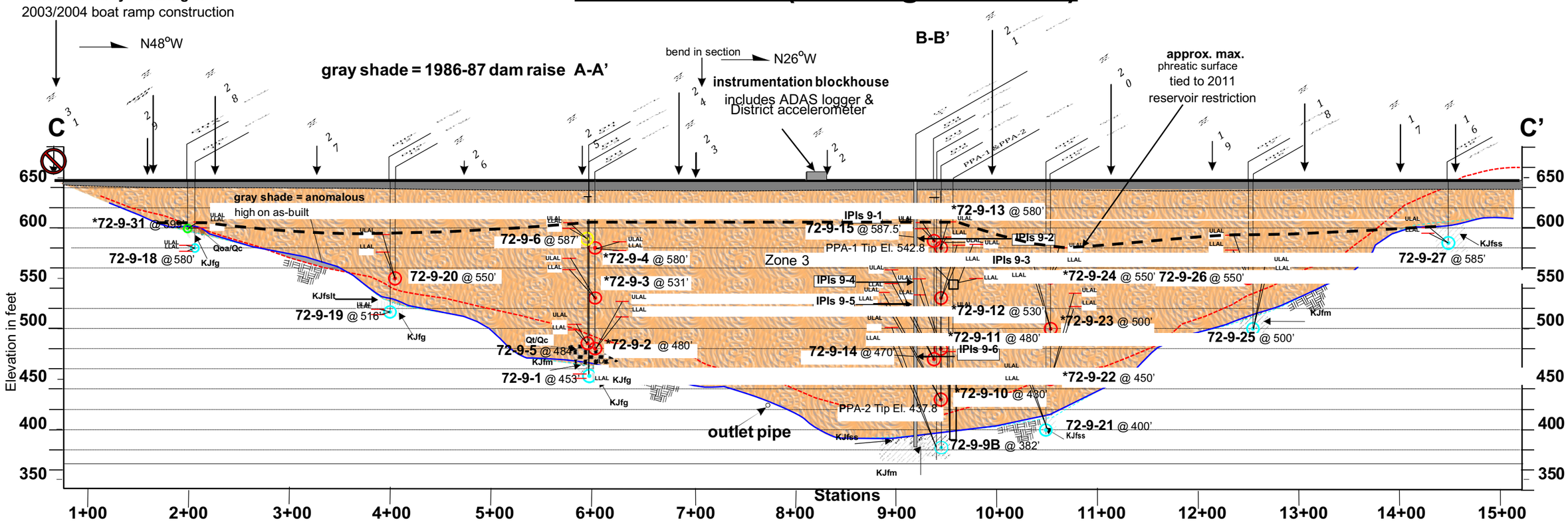
Cross Section B-B'

Leroy Anderson Dam

SCALE 1"=100'

FIGURE 3

Section C-C' (U/S edge of crest)



Explanation

boring number

72-9-ASI-2

automated slope indicator

geophysical/ lithologic logging

72-9-27 vibrating wire piezometer

excavated topography (as-built) corrected 2.8' for new datum

original topography corrected 2.8' for new datum

excavated topography (as-built) adjusted to DIP drill hole logs

* = installed using grout-in methods (see text)
all other piezometers installed using sand-pack methods

Bedrock and Foundation Soil Units from DIP

Qoa/Qc = Quaternary older alluvium and/or colluvium

KJfm = Franciscan Complex melange

KJfg = Franciscan Complex greenstone

KJfss = Franciscan Complex sandstone

red = embankment

green = colluvium/alluvium

blue = foundation

Action Levels

tied to 2011 res. restricted elev. 602.3 ft

Range of acceptable piezo surface

ULAL = upper limit action level

LLAL = lower limit action level

*72-9-31 @ 599'

Notes:
1) File: W:\Geology\DAMS\Historic_Dam_Geology\Anderson\andxsecC-CDIP.cdr
2) basis of elevations is NAVD 1988-elevations are 2.80' higher than NGVD 1929

DATE 12/08/11	Santa Clara Valley Water District	Longitudinal Cross Section C-C'	SCALE 1"=100'
DESIGN JLN		Leroy Anderson Dam	FIGURE 4
DRAWN JLN			
CHECKED DEH			

Reported rainfall is measured at District Rain Gauge No. 41-2073, which is located a few hundred feet southeast of the left abutment of Leroy Anderson Dam.

4.0 SURVEILLANCE INFORMATION

This report graphically depicts surveillance data as time-series plots of reservoir levels and rainfall (Figure 5), time-series and cross plots of piezometers (Figures 6 through 13), time-series and cross plots of spillway underdrain weirs (Figure 14), and time-series plots of crest and spillway training wall monument surveys (Figures 15 through 17). This report also includes plots of inclinometer readings versus depth (i.e. elevation of sensor) as shown in Figure 18.

As part of our quality assurance/quality control, reservoir elevation data and piezometric surface elevation data (PSE) are plotted and reviewed in the form of 1) time series plots (PSE versus time) and 2) cross plots (PSE versus reservoir elevations). Piezometer cross plots of all VWPs are shown as insets in Figures 6 through 13 and a weir seepage discharge cross plot is shown as Inset Figure 14. Also shown for reference are previous and current reservoir restrictions.

4.1 Description of Instrumentation and ADAS

The reader is referred to the DSSMP (Nelson, 2009) for a complete description of all instrumentation and ADAS at Anderson Dam.

4.2 Outlier Data

Surveillance data that lies outside established action levels summarized on Tables A1 through A5 are considered outlier data. The District follows formal procedures to deal with outlier data to determine if they represent unsafe or alarm conditions.

Except for outlier data from 3 VWPs in late March 2011 (discussed below), there were no significant instances of outlier data during the current reporting period.

Depending on the VWP, during March 25 through March 28, 2011, VWPs 6, 15, and 27 exhibited data that were slightly below the established action levels for the respective instrument. Inset 11g (Figure 12) shows outlier data from VWP-27 located in bedrock in the right abutment, Inset 13a (Figure 13) shows outlier data from VWP-6 located in upstream transition zone materials, and Inset 13d shows outlier data from VWP-15 located in upstream transition materials. The duration of outlier data ranged from one day (3/25/11) for VWP-6 to 4 days (3/25 though 3/28/11) for VWP-27. Because these outliers were only slightly below the action levels for the respective instruments, these instances do not appear to represent unsafe or alarm conditions.

4.3 Data Gaps

Gaps that occurred in the various data sets are discussed in the applicable sections, *Section 4.6.6* for piezometers, *Section 4.7.2* for spillway underdrain flows *Section 4.8.4* for crest survey monuments, *Section 4.8.7* for spillway training wall monuments and *Section 4.9.3,* for in-place inclinometer sensor (IPIs). No significant gaps occurred during the current reporting period in the monument survey data, or in ADAS data since June 2011, when power issues were resolved.

Significant data gaps for ADAS instruments, and manual data collected from piezometers and underdrain flow weirs is defined as the absence of recorded instrument data for a period greater than about 1 month. A data gap for survey data is considered the absence of data over a period of plus or minus ~6 months outside the normally scheduled yearly survey.

ADAS stations are currently working properly with no significant issues.

4.4 Reservoir Restrictions

This section briefly describes reservoir fluctuations during the current recording period and how they relate to reservoir restrictions. Also, some piezometric responses in the dam and foundation are potentially influenced by changes in reservoir levels as discussed in *Section 4.6.4 Piezometer Data.*

The following sections describe the various reservoir restrictions during the current reporting period.

2010 Restriction

In September 2010, AMEC presented findings that confirmed Anderson Dam could be unstable in a major earthquake. As a result, the District proposed an addition restriction of ~17 feet to the 2009 restriction for a total of 37 feet below the spillway and ~57 feet below the dam crest. This preliminary restriction was equivalent to elev. 590.8 feet (NAVD88).

2011 Restriction

Based on findings from their technical memorandum 7 (TM-7), AMEC (2011b) recommended a revised operating restriction between 40 and 45 feet. In a letter dated April 12, 2011, the District proposed a restriction of 45 feet at elev. 602.3 feet (NAVD88). This restriction would be in place until the seismic retrofit of the dam is completed, which is currently anticipated to be the end of 2018; however, the District may request a modification to the restriction following completion of the retrofit for the downstream embankment. This restriction was approved by FERC and DSOD.

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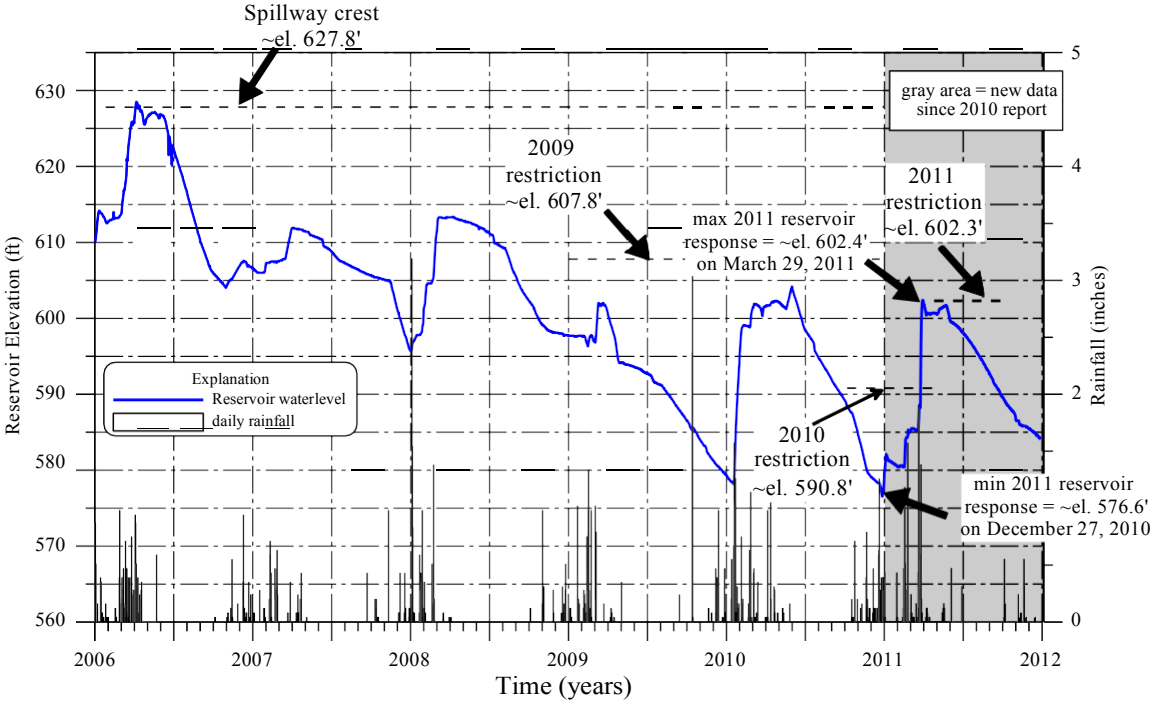
4.5 Annual Reservoir Fluctuation

Figures 5 through 14 show the various reservoir restrictions.

Figure 5 shows the detail of reservoir fluctuation from 2006 through most of 2011 with gray shading that denotes recent data during the current surveillance period from January 2011 to the present. The maximum reservoir excursion for 2011 was el. 602.4 feet (~25 feet below spillway lip el.) on March 29, 2011. In recent years due to reservoir restrictions there has been an overall lowering of maximum reservoir excursions with elev. 628 feet in 2006, elev. 612 feet in 2007, elev. 613 feet in 2008, elev. 602 feet in 2009, and elev. 604.2 in 2010. The last time Anderson Reservoir spilled was in April 2006 (Nelson and Volpe, 2006). Except for a maximum reservoir response 0.1 feet over the current restriction (March 29, 2011) for the current reporting period, the reservoir level has been well below the newer 2011 restriction at elev. 602.3 ft. The preponderance of rainfall for any given calendar year typically occurs during January through April/May (locally known as a "water year").



Notes: 1) basis of elevations is NAVD 1988 - values are 2.8 feet higher than NGVD 1929
2) file W:\geology\dams\annual dam safety reports\FERC\Annual Reports\2011\piez\Andresplot-11

Figure 5. Daily Reservoir Elevation and Rainfall 2006-2011

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4.6 Piezometers

Table 1 summarizes pertinent data of the vibrating wire piezometers (VWP), original pneumatic piezometers, and open well piezometers, including location in the dam, tip elevation and surface elevation.

Table 1
Locations of Vibrating Wire Piezometers
Pneumatics and Open Well Piezometers
Anderson Dam

Embankment Piezos		
Downstream Core Zone 3	Tip Elev. (ft)	Surface Elev. (ft)
72-9-02*	480	647
72-9-03*	531	647
72-9-04*	580	647
72-9-05	484	631
72-9-10*	430	647
72-9-11*	480	647
72-9-12*	530	647
72-9-13*	580	647
72-9-20	550	647
72-9-22*	450	647
72-9-23*	500	647
72-9-24*	550	647
72-9-26	550	647
72-9-29*	444	614
72-9-30*	490	614
PPA-1	540	647
PPA-2	435	647
Upstream Core Zone 2	Tip Elev. (ft)	Surface Elev. (ft)
72-9-14	470.0	630.0

Transition Zone		
Downstream	Tip Elev. (ft)	Surface Elev. (ft)
72-9-07	557	619
72-9-08	518	602
72-9-16*	539	614
72-9-17	421	583
Upstream	Tip Elev. (ft)	Surface Elev. (ft)
72-9-06	587.0	631
72-9-15	587.0	630.0

Foundation Fill Lower Finer Fill		
Foundation	Tip Elev. (ft)	Surface Elev. (ft)
OW-2	406	508

Bedrock Foundation		
Foundation	Tip Elev. (ft)	Surface Elev. (ft)
72-9-01	453	647
72-9-9B	382	647
72-9-18	580	647
72-9-19	516	647
72-9-21	400	647
72-9-25	500	647
72-9-27	585	647

Alluvial/Colluvial Foundation		
Foundation	Tip Elev. (ft)	Surface Elev. (ft)
72-9-28	405	486.0
72-9-31*	600	647
OW-1	399	417
OW-3	408	551

Note:
1) * = piezometer installed using grout-in methods
2) all other piezometer installed using sand-pack methods
3) W:\Geology\DAMS\Annual Dam Safety Reports\FERC\AnnualReports\2011\piez\Andtab1-11.xls

4.6.1 Pneumatic Piezometers

Two pneumatic piezometers (PPA-1 and PPA-2), installed in 1975, show slight fluctuations and response to changes in reservoir levels but are still operational after 36 years of service.

4.6.2 Vibrating Wire Piezometers

The District manually collected data from 31 VWPs from their installation in late December 2006 until implementation of ADAS in early December 2008. Most data since December 2008 has been automatically collected by ADAS. The locations of the VWPs are shown in plan view in Figure 1 and in section views in Figures 2, 3, and 4.

As summarized in Table 1, locations of the piezometers include 16 VWPs in the downstream core (Zone 3) of the embankment, 1 VWP in the upstream core (Zone 2) (with core piezometers shown as red symbols in Figures 2, 3, and 4), 4 VWPs in the downstream transition zone (yellow symbols), 2 VWPs in the upstream transition zone, 2 VWPs in alluvium/colluvium (green symbols), and 7 VWPs in foundation Franciscan Complex bedrock (blue symbols).

4.6.3 Open Well Piezometers

The locations of the open well piezometers are shown in Figures 1 and 3. As summarized in Table 1, piezometer OW-2 targets the phreatic surface of a lower fine-grained unit of rockfill embankment encountered during the SSE1A investigation and identified as the "Lower Finer Fill" (LFF) at depths between 89 feet and 105 feet (~elev. 403 feet and 419 feet). Well OW-3 targets the phreatic surface of various foundation soils including construction haul road fill and alluvium at depths between 132 feet and 141 feet (~elev. 410 feet and 418 feet).

Supplemental data from OW-2 and OW-3 were collected by AMEC during the SSE1A investigation and the District began monitoring water levels on a regular basis (roughly monthly) in OW-2 and OW-3 in October 2009.

4.6.4 Piezometer Data

Recent pneumatic and newer open well piezometer data collected since our last report (Nelson, 2010) from January 2010 through December 2011 are summarized in Table 2.

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TABLE 2
Recent Piezometric Data
Leroy Anderson Dam)

Date	Reservoir Level	PPA-1	PPA-2	OW-1	OW-2	OW-3	Monthly*
		ground surface elev. =		416.8	507.6	550.5	
	(ft)	Piezometric Surface Elevation (ft)					Rainfall (in)
12/20/10	578.4	570.9	498.2	405.8	406.6	411.5	5.2
1/18/11	581.1	570.5	489.3	406.2	407.6	411.8	0.9
2/23/11	584.3	568.9	492.1	406.4	406.6	411.8	4.4
3/15/11	585.3	569.5	508.3	406.3	406.3	411.8	6.1
4/25/11	600.7	571.6	493.9	406.3	406.6	411.8	0.3
5/23/11	601.6	571.3	494.4	405.9	406.6	411.7	0.5
6/15/11	599.1	568.2	494.6	406.3	406.2	412.0	0.8
7/19/11	596.8	570.8	493.9	405.2	406.6	411.7	0.0
8/29/11	592.9	571.0	496.2	406.2	406.4	412.5	0.0
9/21/11	592.6	570.1	494.0	406.2	406.5	411.9	0.0
10/27/11	587.7	570.5	497.6	406.1	406.5	411.6	0.9
11/17/11	585.8	570.1	495.6	406.1	404.9	411.5	1.2
12/8/11	585.2	570.8	497.0	406.2	404.7	411.6	0.0

Notes:
1) Piezometer data is Piezometric Surface Elevation (PSE in feet)
2) PSE = pressure head (ft) + elevation head (ft)
3) basis of elevations is NAVD 1988 - values in this table are 2.8 feet higher than NGVD 1929
4) Installation dates: OW-1 on 8/5/03, OW-2 on April 30, 2009, and OW-3 on May 1, 2009
5) file: W:\Geology\DAMS\Data\Pz\Anderson.xls

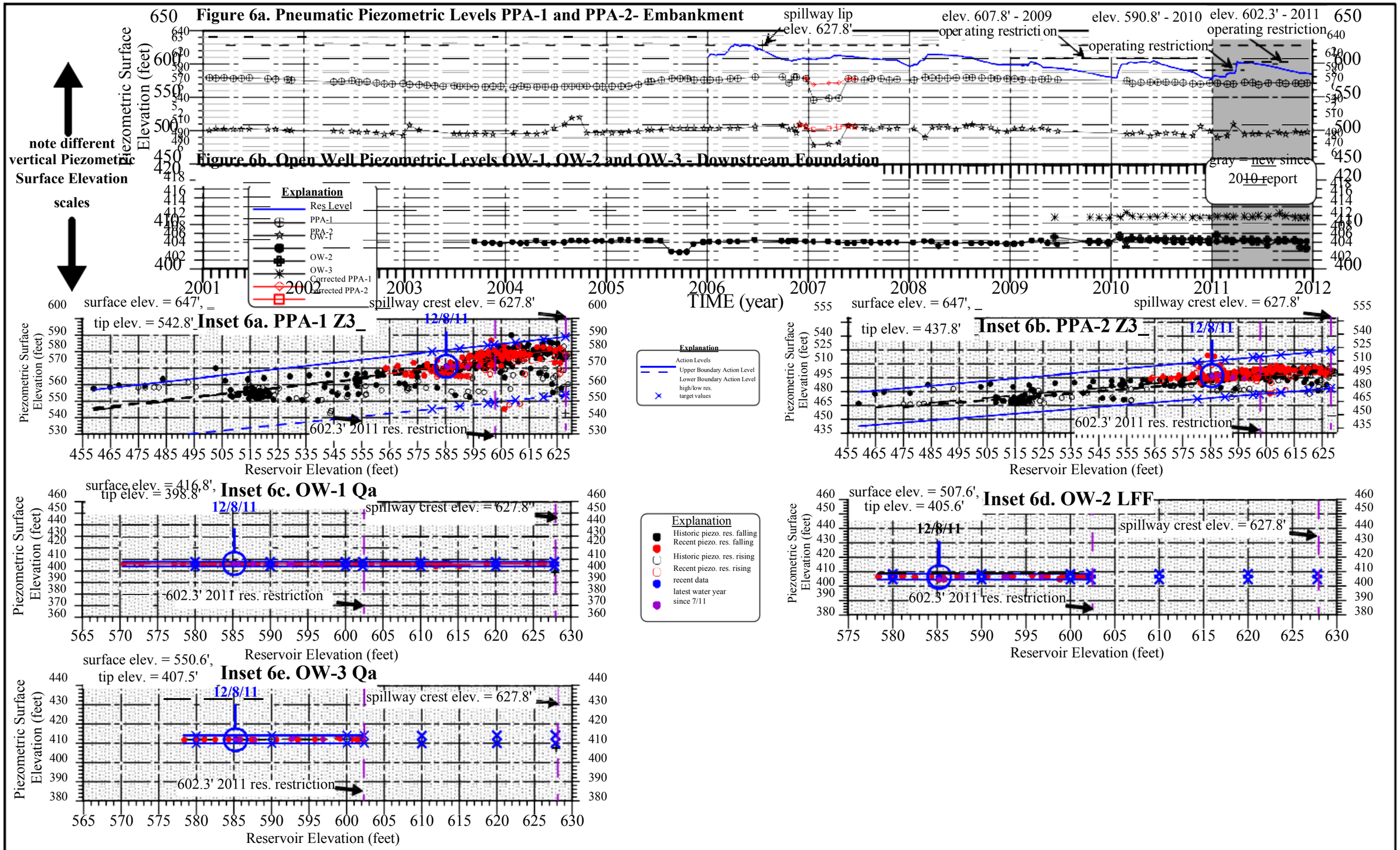
The piezometer data presented in Figures 6 through 13 are time-series plots of piezometric surface elevation (PSE) vs. time for each piezometer. The PSE is defined as the sum of the piezometer tip elevation (feet) and the hydraulic pressure head (feet).

Figure 6 shows pneumatic and open well piezometric levels as piezometric surface elevation (PSE), reservoir levels, and monthly rainfall data for the most recent 10 year period from January 2001 through December 2011. Table 2 and the gray area of Figure 6 show data since our 2010 report (Nelson, 2010).

Overall, the data indicates that fluctuations in these piezometric levels show a muted response to fluctuations in reservoir level. Pneumatic piezometers PPA-1 and PPA-2, located in the lower portion of the central clay core, consistently show minor variations in piezometric elevations under a wide range of reservoir fluctuations.

The pneumatic piezometer data appear to be providing reliable and consistent data during the entire surveillance period.

As shown in Figure 6, since installation of the open wells OW-1, OW-2, and OW-3, the piezometric surface in these wells have varied over relatively narrow ranges. For 2011, piezometric elevations in OW-1 (located about 50 feet from the downstream toe of the dam) were consistently ~elev. 405.2 feet to 406.4 feet, which corresponds to a depth of ~10 ½ feet below ground surface. OW-2 has varied from elev. ~405 feet to ~408 feet and OW-3 has varied from

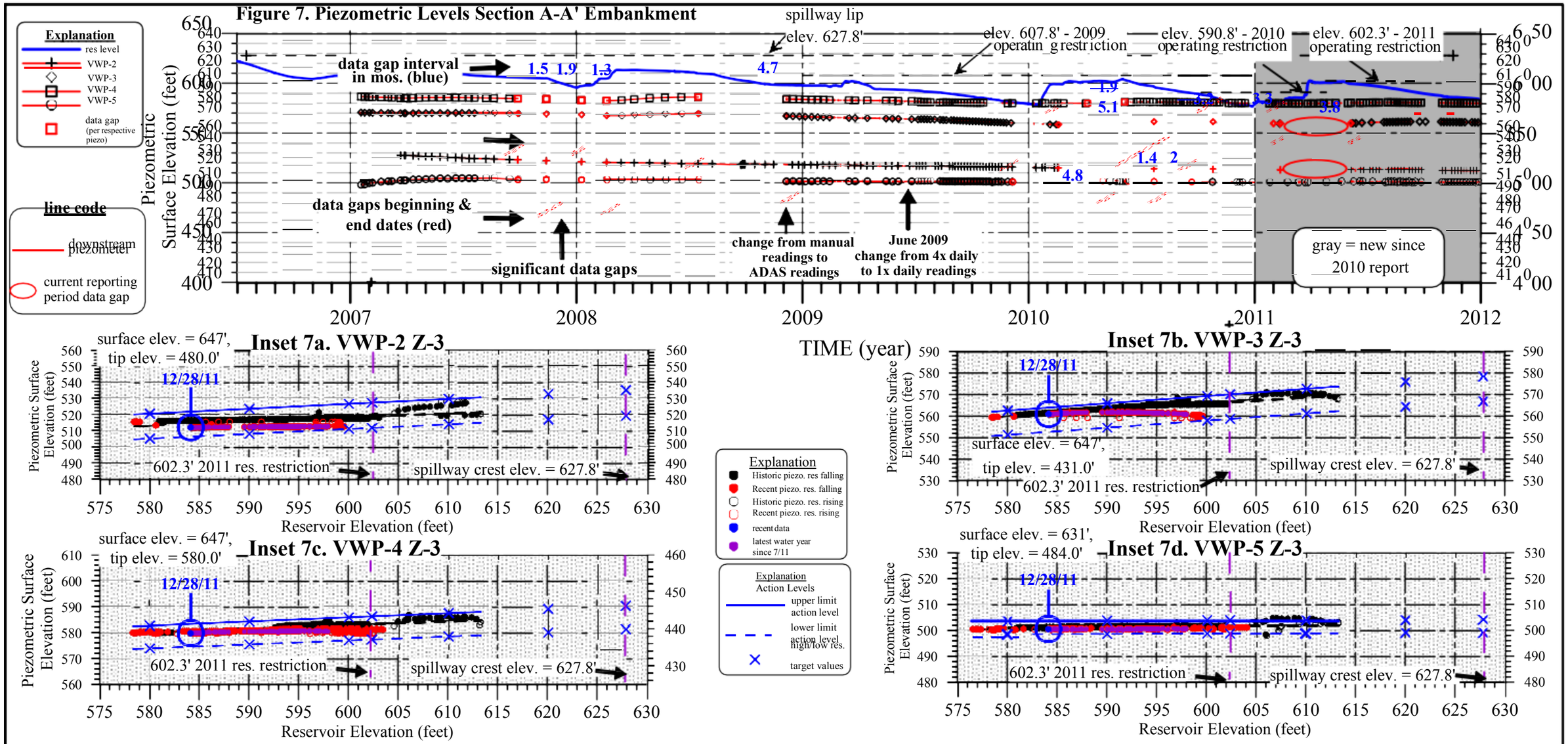


Notes:
1) Basis of elevations is NAVD 1988 - values on this plot are 2.8 feet higher than NGVD 1928
2) File W:\Geology\DAMS\Annual Dam Safety Reports\FERC\Annual Reports\2011\Piez\Andpneu&ows-11.grf

Santa Clara Valley Water District

Recent Piezometric Data - Pneumatic and Open Wells
Embankment & Downstream Foundation
Leroy Anderson Dam

FIGURE
6

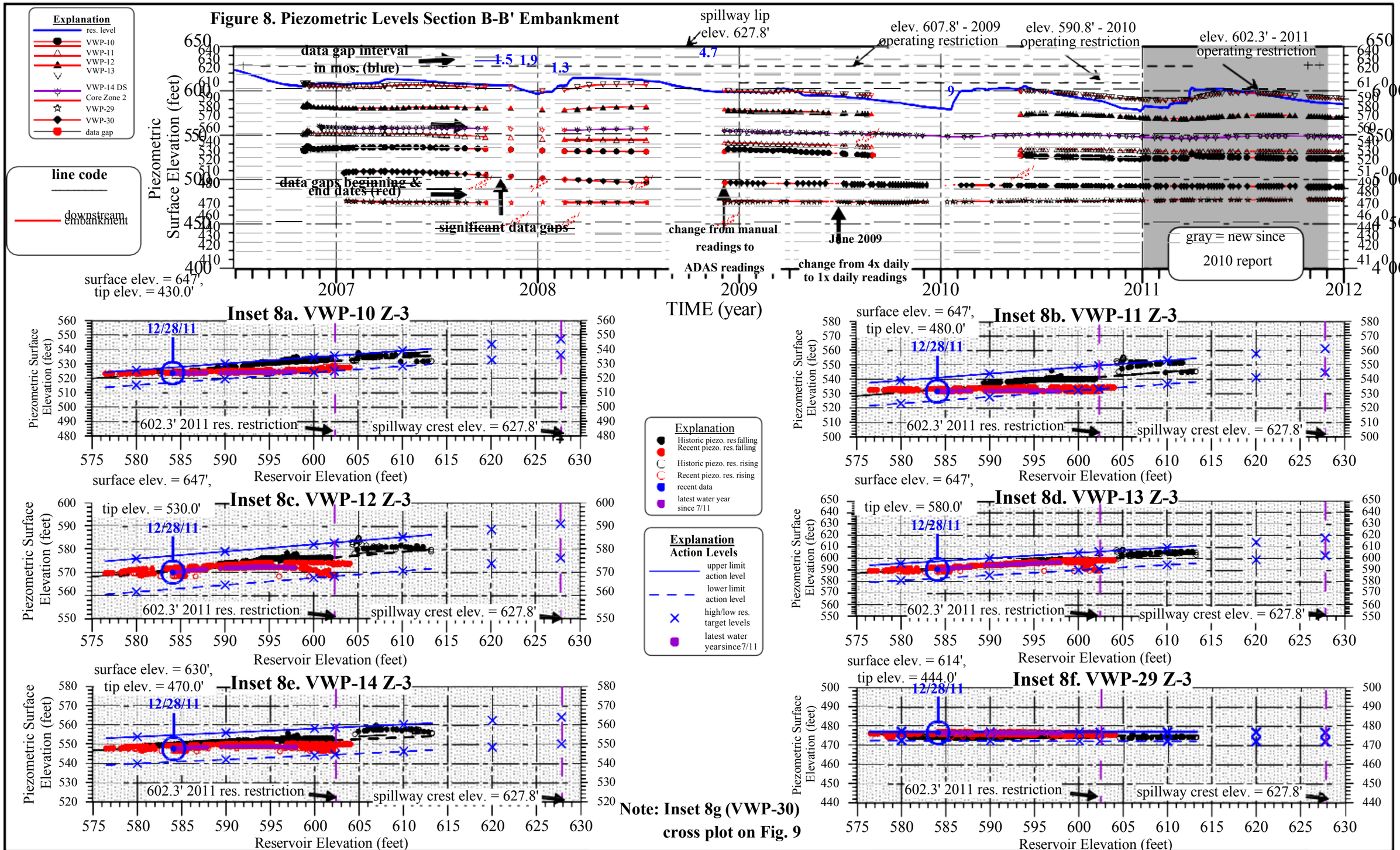


Notes:
1) Basis of elevations is NAVD 1988 - values on this plot are 2.8 feet higher than NGVD1928
2) File W:\Geology\DAMS\Annual Dam Safety Reports\FERC\Annual Reports\2011\Piez\AndSectionA-11.grf

Santa Clara Valley Water District

Recent VW Piezometric Data
Section A-A' - Embankment
Leroy Anderson Dam

FIGURE
7



Notes:
1) Basis of elevations is NAVD 1988 - values on this plot are 2.8 feet higher than NGVD1928
2) File W:\Geology\DAMS\Annual Dam Safety Reports\FERC\AnnualReports\2011\Piez\AndSectionB-11.grf

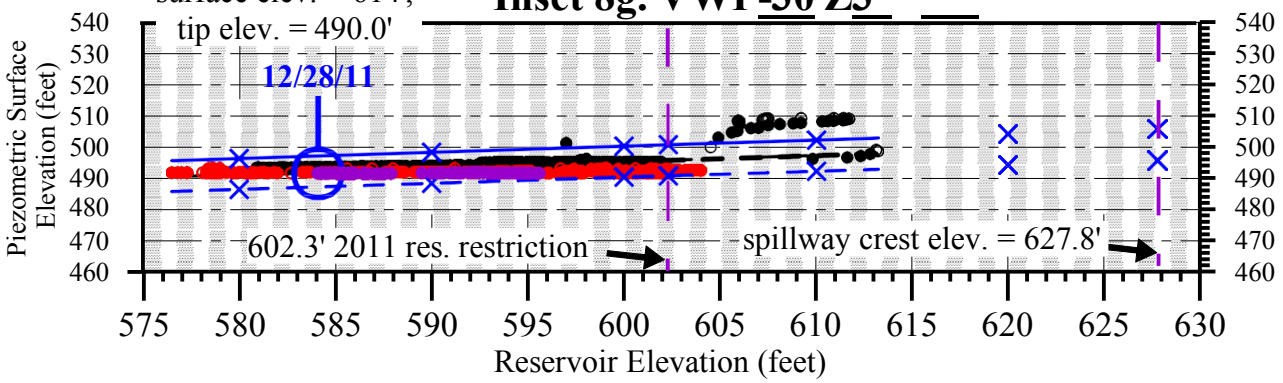
Santa Clara Valley Water District

Recent VW Piezometric Data
Section B-B' - Embankment
Leroy Anderson Dam

FIGURE
8

Cross Plot Continued from Figure 8

Inset 8g. VWP-30 Z3



Explanation

Action Levels

- Upper Boundary Action Level
- Lower Boundary Action Level
- Boundary target res. levels

Explanation

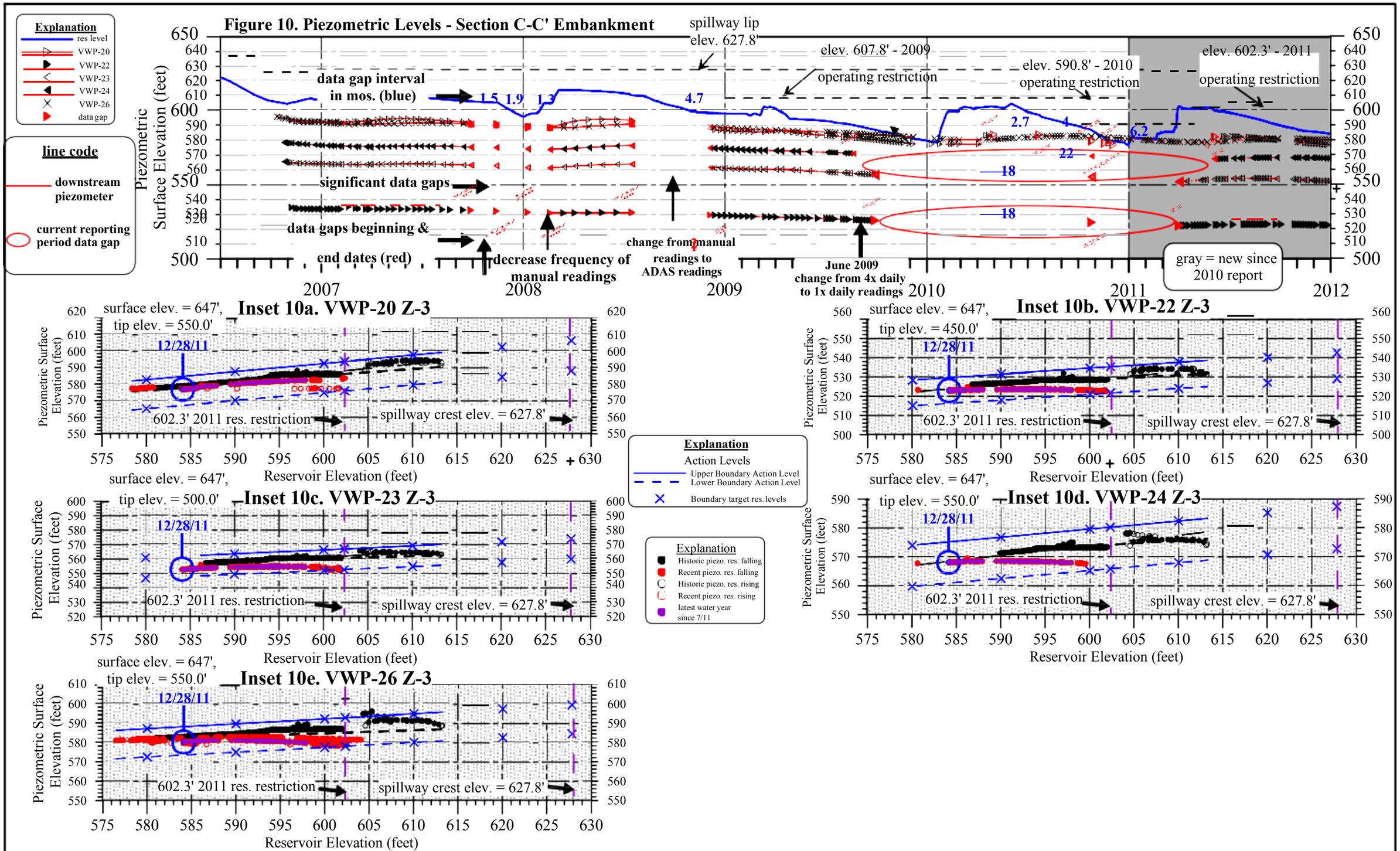
- Historic piezo. res rising
- Historic piezo. res. falling
- Recent piezo. res. rising
- Recent piezo. res. falling
- recent data
- latest water year since 7/11

Notes: 1) Basis of elevations is NAVD 1988 - values on this plot are 2.8 feet higher than those dated earlier than 1998
2) file W:\geology\dams\annual dam safety reports\FERC\Annual Reports\2011\Piez\AndInset8g-11.grf

Santa Clara Valley Water District

Recent Piezometric Data
Inset 8g Cross Plot
Leroy Anderson Dam

FIGURE 9

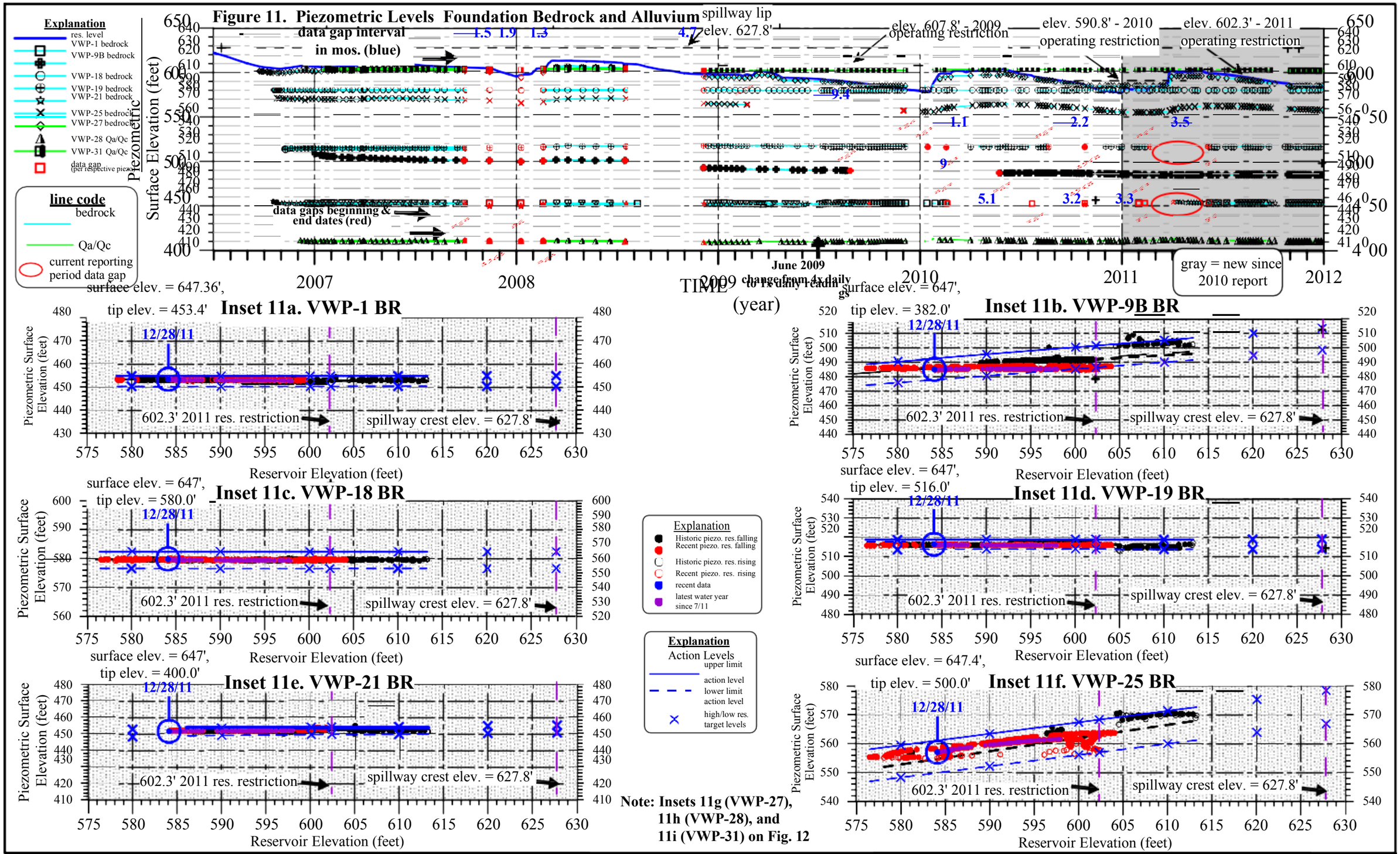


Notes:
1) Basis of elevations is NAVD 1988 - values on this plot are 2.8 feet higher than NGVD1928
2) File W:\Geology\DAMS\Annual Dam Safety Reports\FERC\AnnualReports\2011\Piez\AndSectionC-11.grf

Santa Clara Valley Water District

Recent VW Piezometric Data
Section C-C' - Embankment
Leroy Anderson Dam

FIGURE
10



Notes:
1) Basis of elevations is NAVD 1988 - values on this plot are 2.8 feet higher than NGVD 1928
2) File W:\Geology\DAMS\Annual Dam Safety Reports\FERC\Annual Reports\2011\Piez\AndFound-11.grf

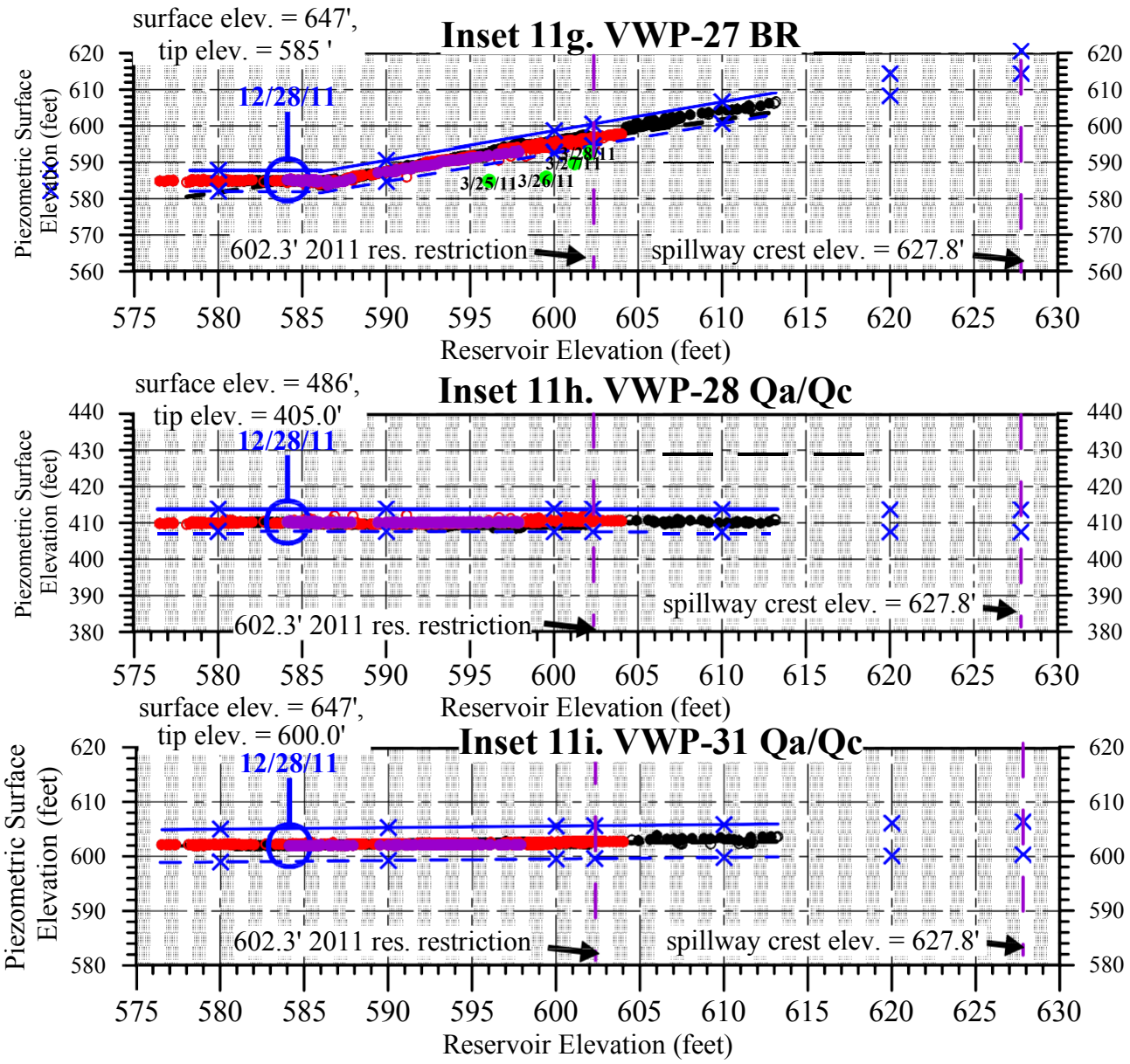
Santa Clara Valley Water District

Recent VW Piezometric Data - Foundation

Leroy Anderson Dam

FIGURE 11

Cross Plots Continued from Figure 11



Explanation
Action Levels
- Upper Boundary Action Level
- Lower Boundary Action Level
- Boundary target res. levels
- data outside action level and date

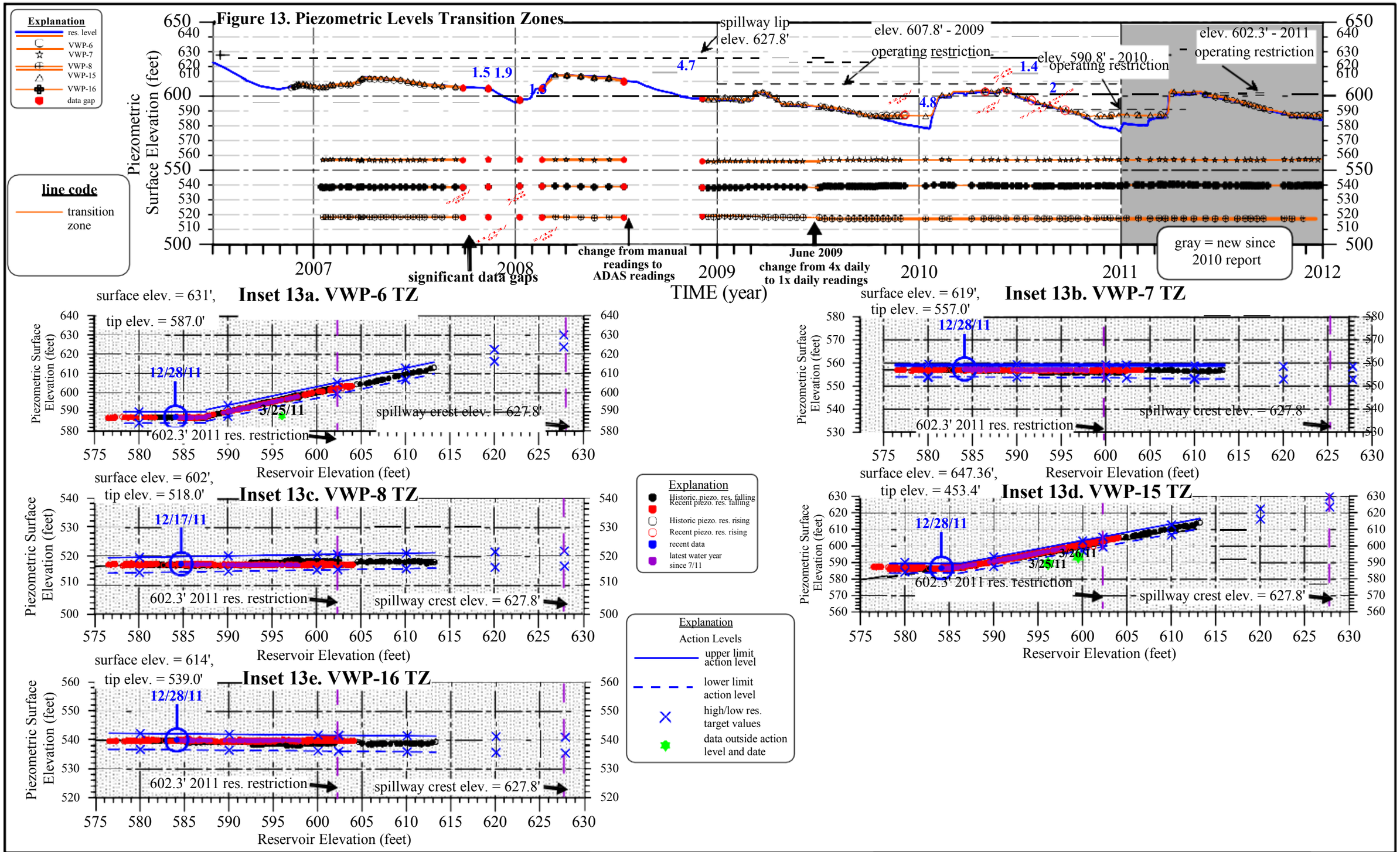
Explanation
- Historic piezo. res. falling
- Recent piezo. res. falling
- Historic piezo. res. rising
- Recent piezo. res. rising
- most recent data
- latest water year since 7/11

Notes: 1) Basis of elevations is NAVD 1988 - values on this plot are 2.8 feet higher than those dated earlier than 1998
2) file W:\geology\dams\annual dam safety reports\FERC\Annual Reports\2011\Piez\AndInset11g-11i-11.grf

Santa Clara Valley Water District

Recent Piezometric Data
Insets 11g thru 11i Cross Plots
Leroy Anderson Dam

FIGURE 12



Notes:
1) Basis of elevations is NAVD 1988 - values on this plot are 2.8 feet higher than NGVD 1928
2) File W:\Geology\DAMS\Annual Dam Safety Reports\FERC\Annual Reports\2011\Piez\AndTZ-11.grf

Santa Clara Valley Water District

Recent VW Piezometric Data - Transition Zones
Leroy Anderson Dam

FIGURE 13

elev. ~411 feet to 412 feet. Long-term trends of the phreatic surface in these wells have not been established.

4.6.5 Vibrating Wire Piezometer (VWP)

The maximum Anderson Reservoir elevation since installation of the VWPs and their first readings in November 2006 was about 613.4 feet on April 9, 2008, which is about 14 feet below the spillway lip. The maximum for the current reporting period was 602.4 feet on March 29, 2011, which is about 25 feet below the spillway lip.

Figures 7, 8, and 10 show 3 time-series plots of VWP surface elevation (PSE) data from the embankment versus time along sections A-A', B-B', and C-C'. Figure 11 shows plots of PSE data versus time for foundation bedrock VWPs. Figure 13 shows PSE time-series plots of transition zone VWPs. Reservoir elevation data are presented for reference. Due to various restrictions since 2009, the VWPs installed in 2007 (DIP) and 2010 (SSE1A) have not experienced possible maximum VWP excursions. The recent data obtained since our last report (Nelson, 2011) from January 2011 through December 2011 is shown as a shaded region on Figures 7 through 13.

There are a number of pertinent observations based on VWP information to date. These are summarized below.

- Based on the muted response of core VWPs as indicated in Figures 7, 8, 10, and 11, hydraulic pressures being imposed by the dam are being safely dissipated by head losses through the core in a safe and effective manner. This is evident by 16 VWPs located within the U/S Zone 2 and D/S Zone 3 core sections (see Table 1) that indicate no significant variations in hydraulic head losses across the entire width or length of the dam.

- Except for VWPs in the left abutment (18 & 31) and right abutment (25 & 27) (see discussion below), the majority of the foundation VWPs are measuring only a fraction of the total possible pressure head at various locations beneath the core of the dam (Figure 11). This supports the effectiveness of the foundation preparation including the removal of surficial soils (i.e. alluvium and colluvium) beneath the core during construction and the fact that the vast majority of the clay core rests on and is in direct contact with either predominantly competent Franciscan Complex bedrock or semi-consolidated Santa Clara Formation sediments.

- The left and right abutment VWPs (18, 31, 25, and 27) in bedrock (Franciscan Complex and possibly Santa Clara Formation) appear to have relatively high PSE values based on their relatively high tip elevations (580 ft, 600 ft, 500 ft, and 585 ft, respectively) and the likelihood that these VWPs are located in bedrock that may be slightly more permeable than the clay core. VWP 18 is essentially dry with a PSE value close to the tip elevation; VWP 31 has PSE values ~2 ft higher than the tip elevation; VWP 25 has PSE values that range from ~55 ft to ~64 ft higher than tip elevation; and VWP 27 has PSE values that range from ~2 ft to 15 ft higher than the tip elevation. VWP 27 is also one of the few piezometers that noticeably respond to reservoir changes. VWP 31 is noteworthy because, regardless of how much the reservoir drops, the minimum PSE stays at about elev. 602 ft. Currently, PSE values in VWP 31 are at ~elev. 602.1 ft while reservoir elevation is ~elev. 578 ft, indicating that the phreatic level in VWP 31 is ~24 ft higher

than the reservoir. The tip of VWP 31 is located at a relatively high elevation (~600 ft) in the left abutment. This higher pore pressure response relative to reservoir levels likely reflects the concept of storage retention or field capacity when a porous media is drained. It is also possible that local groundwater conditions govern the water level in VWP 31.

- Based on the results of two upstream transition zone VWPs (6 and 15), there is essentially no loss (dissipation) of reservoir head through the upstream rockfill shell and transition zone, which means that the full reservoir hydrostatic head is acting along the upstream sloping face of the core. This performance is expected because the upstream rockshell and transition zones are very permeable.

- Four VWPs were installed within the downstream transition zone, including 7 and 8 in Section A-A (Figure 2), and 16 and 17 in Section B-B' (Figure 3). These four VWPs are all measuring PSE values essentially at their respective tip elevations indicating that the phreatic surface in these VWPs is below the tip (i.e. dry holes), which indicates that the downstream transition zone and overlying rockfill zone are essentially dry. These results indicate that the transition zone is effectively capturing the phreatic surface as it exits the downstream face of the core.

- VWP 28, OW-1, OW-2, and OW-3 are located in the downstream foundation, with OW-1 actually located about 50 feet beyond the downstream toe very close to the maximum section. OW-2 and OW-3 monitor the downstream foundation consisting of lower finer fill (OW-2) and haul road fill/alluvium (OW-3). These VWPs have a drop in maximum PSE value of about 4.7 feet over a horizontal distance of about 400 feet. This computes to a relatively low horizontal seepage gradient of about 0.02 (6'/400') in the downstream toe area.

Except for the 4 VWPs in the upsteam transition zone that directly respond to fluctuations in reservoir levels, the older open well, pneumatic wells, and embankment VWPs indicate that piezometric levels generally exhibit either a muted response where piezometer excursions show a suppressed response relative to the reservoir, or a "flat-line" plot where the piezometer doesn't seem to track reservoir excursions. These responses appear to be due to the low permeability clay core. The piezometric levels in all piezometers tend to fall within the typical ranges of historical levels. No abnormal readings or trends are evident.

As evident from time-series plots of Figure 6c and cross plots insets 6d, and 6e, not enough data has been collected from open wells OW-2 and OW-3 to evaluate their long-term response to changes in reservoir levels. Based on limited data, these piezometers appear to respond similar to OW-1, with essentially no response to reservoir changes.

4.6.6 Piezometer Data Gaps

The District appeared to resolve the power supply issues in June 2011, and is currently obtaining fairly continuous data readings from all VWPs. Prior to June 2011 there were several data gaps as shown in Figure 7 for VWPs 2 and 3, Figure 10 for VWPs 20, 22, 23, and 24, and in Figure 11 for VWPs 1, 19 and 21. Duration of gaps ranged from 3.5 months (VWP-19) to 21.8 months (VWP-24).

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4.7 Spillway Underdrain System

The current spillway underdrain discharge monitoring program for Anderson Dam Spillway began in May 1993. From 1993 to 1999 discharge was measured only at the "center" drainage system which collects seepage in the central portion of the spillway. The "left" drainage system discharged through boulders that were providing slope protection D/S of the spillway bucket and could not be measured.

In 1999 a new weir system allowed all discharge to be measured instead of only a portion of the flow as occurred with the original center drainage system mentioned above. Weir #1 measures the seepage from the "center" drainage system but is not affected by the restriction and backpressure created by the use of a meter, as was the old system that it replaced. Weir #2 measures the seepage collected along the left (southern) side of the spillway.

4.7.1 Spillway Underdrain Flow Data

Our surveillance reports only provide historic data plots covering the last 10 years (since ~ 2001). Spillway underdrain flow data was formerly collected using a flow meter. This report only shows plots of the weir discharge data. Historic flowmeter data are summarized in previous surveillance reports. Figure 14 shows monthly rainfall and data from weirs No. 1 and No. 2 from January 2001 through December 2011. Table 3 shows recent data since the 2010 report.

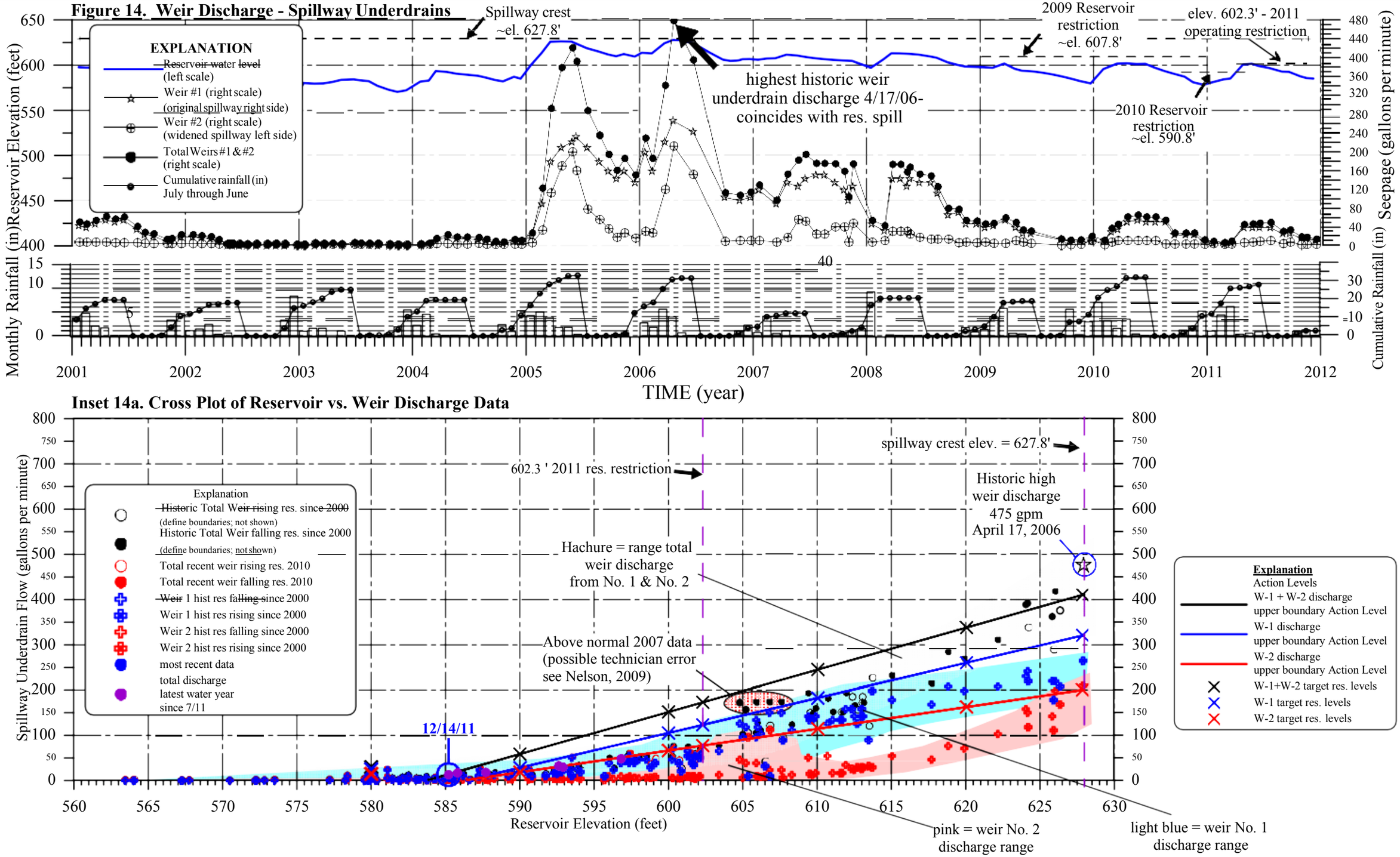
During 2011, the combined flow from the weirs ranged from a low of ~5 gallons per minute (gpm) (February 2011) to a high of ~48 gpm (July 2011). The overall flow is relatively small during the period of this surveillance report due to relatively low reservoir levels as discussed in *Section 4.5 Annual Reservoir Fluctuation*.

TABLE 3
Recent Weir Discharge Data – Spillway Underdrains
Leroy Anderson Dam

Date	Reservoir	Underdrain flow (gpm)		Total flow
	Level (ft)	Weir No. 1	Weir No. 2	(gpm)
12/20/2010	578.4	9.4	1.8	11.2
1/18/2011	581.1	4.9	3.1	8.1
2/23/2011	584.3	3.6	1.8	5.4
3/15/2011	585.3	6.3	2.3	8.5
4/25/2011	600.7	38.6	4.9	43.5
5/23/2011	601.6	38.6	6.3	44.9
6/15/2011	599.1	38.6	8.1	46.7
7/19/2011	596.8	38.6	9.4	48.0
8/29/2011	592.9	26.0	3.1	29.1
9/21/2011	592.6	26.0	6.3	32.3
10/27/2011	587.7	16.6	0.9	17.5
11/14/2011	585.8	14.8	1.8	16.6
12/14/2011	585.2	10.8	1.8	12.6

Notes: 1) Weir No. 1 collects flow from the central portion of spillway
2) Weir No. 2 collects flow from the left side of the spillway
3) NR = not read due to unsafe access; --- = not applicable
4) 12/14/11 reading taking after manual piezo readings on 12/8
5) W:\Geology\DAM S\Annual Dam Safety Reports\DSOD\

Figure 14. Weir Discharge - Spillway Underdrains



Notes:

1) Basis of elevations is NAVD 1988 - values on this plot are 2.8 feet higher than NGVD 1928
2) File W:\Geology\DAMS\Annual Dam Safety Reports\FERC\Annual Reports\2011\Andweirtime&crossplts-11.grf

Santa Clara Valley Water District

Weir Discharge Data - Spillway Underdrains

Leroy Anderson Dam

FIGURE 14

4.7.2 Spillway Underdrain Flow Data Gaps

There were no significant underdrain flow data gaps during the current reporting period.

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4.8 Monument Surveys

4.8.1 Survey Procedures

Crest monuments were surveyed at the times indicated (typically once per year). Vertical survey data is collected and processed following the same methods used previously, traditional closed loop least squares adjusted leveling technique. Survey of monuments at Anderson Dam consists of using GPS techniques with data format in X-Y coordinates (eastings and northings, respectively). Offset (transverse) displacement data either upstream or downstream relative to the monument line established are calculated from the coordinate data using trigonometric relationships assuming stable reference points away from the dam and located in the right and left abutments. The reference baseline for the transverse displacement calculation uses the coordinates of the end points, assumed to be relatively stable monuments in bedrock immediately right and left of the dam, at the time the survey was first established.

During the period of this report, crest monuments (No. 16 through No. 30) and training wall monuments (No. 14 and No. 15) were monitored at the locations shown in Figure 1 (plan view) and in Figure 4 (longitudinal section view). After monument 31 was destroyed in ~2004, monument 30 was established as the left abutment control endpoint as the reference point to determine local transverse displacements.

Since July 1988 the District has used Global Positioning Satellite (GPS) methods to survey new crest monuments installed at Anderson Dam after the 1986-87 dam raise.

"Vertical" and "transverse" survey data collected since the December 2010 report (Nelson, 2010) are shown as gray shading on Figures 15, 16 and 17.

4.8.2 Dam Crest and Abutment Monuments

The crest monuments generally alternate between the downstream edge and upstream edge of the crest. Data plots have been grouped as either "upstream (U/S) edge" or "downstream (D/S) edge". The location of the surface monuments are shown in Figure 1 (plan view) and Figure 4 (longitudinal section view).

4.8.3 Survey Data – Dam Crest and Abutments

During the period of this report, dam crest monuments No.16 through No. 30 were monitored and their locations are shown on Figure 1. The vertical and transverse data for Anderson Dam is presented in Figures 15 and 16, and summarized on Table 4. Net vertical and transverse displacements since the last surveillance report (i.e. from October 2010 to the October 2011 survey) is shown at the bottom of each data set on Table 4.

Survey results of crest and abutment monuments indicate minimal horizontal and vertical displacements (less than 0.01 ft in the vertical plane and 0.02 in the horizontal plane) have occurred during this reporting period. These small displacements indicate that only minimal, normal displacements of the dam have occurred during this reporting period with no obvious trends.

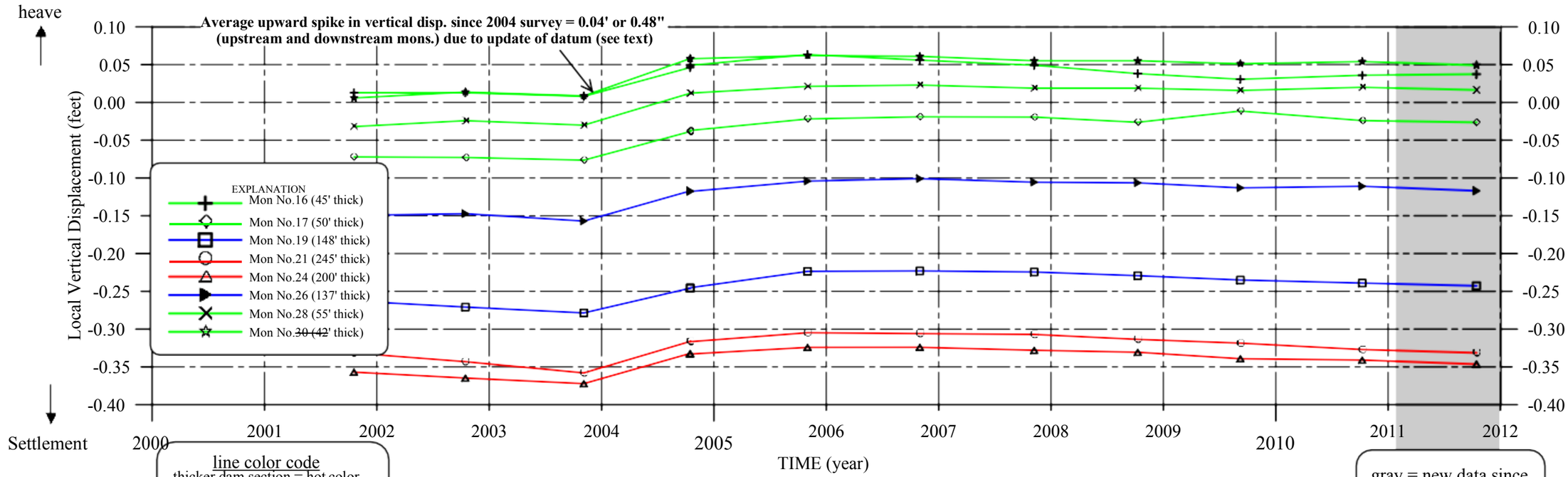

Figure 15a. Recent Local Vertical Displacements - Downstream Monuments

line color code
thicker dam section = hot color
thinner dam section = cool color
0' to 100' dam thickness
100' to 150' dam thickness
150' to 255' dam thickness

gray = new data since Dec 2010 report

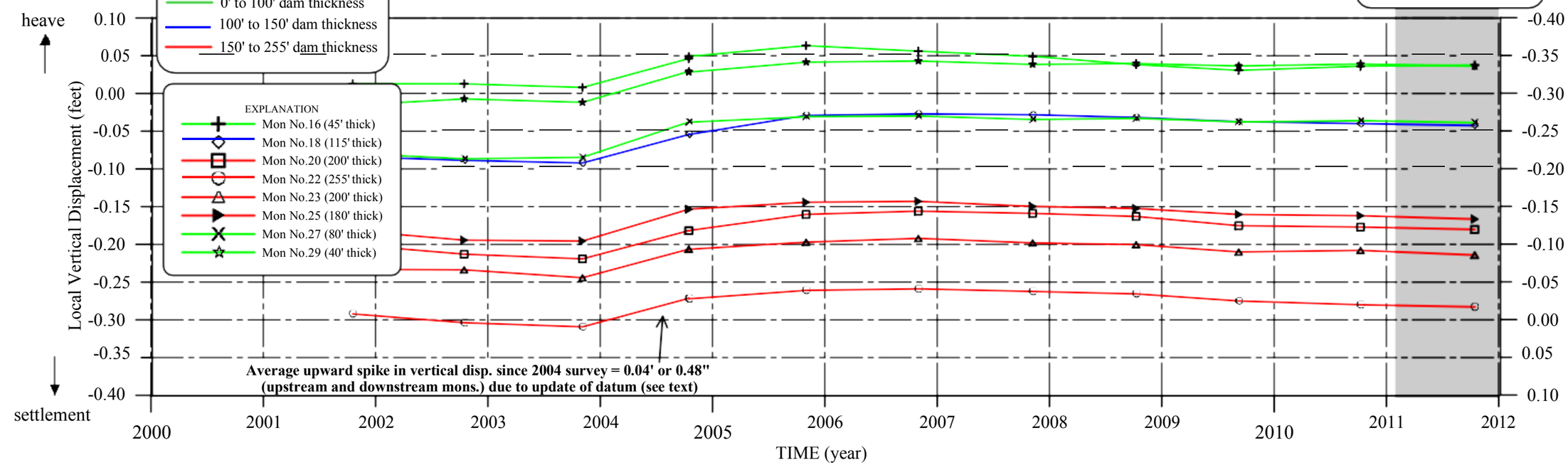

Figure 15b. Recent Local Vertical Displacements - Upstream Monuments

Notes:
1) File W:\Geology\DAMS\Annual Dam Safety Reports\FERC\Annual Report\2011\survey\AndDS&USvertPlots-11.grf
2) Since the 2004 survey the District no longer shows changes in datums

Santa Clara Valley Water District

Recent Local Vertical Displacement
- Downstream and Upstream Crest Monuments
Leroy Anderson Dam

FIGURE
15

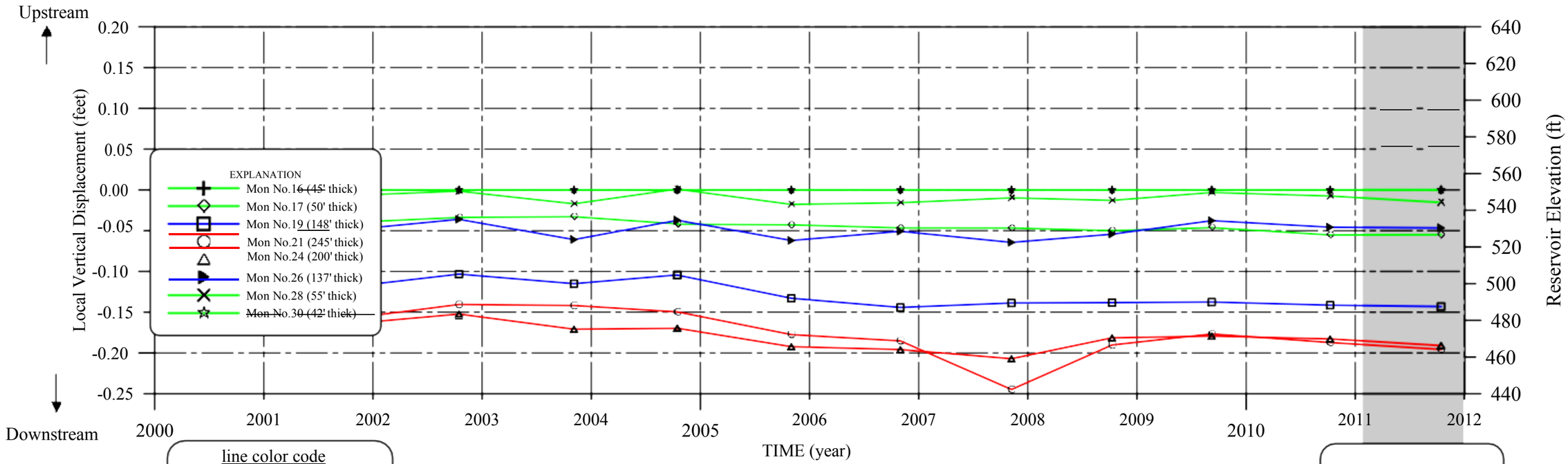

Figure 16a. Recent Local Transverse Displacements - Downstream Monuments

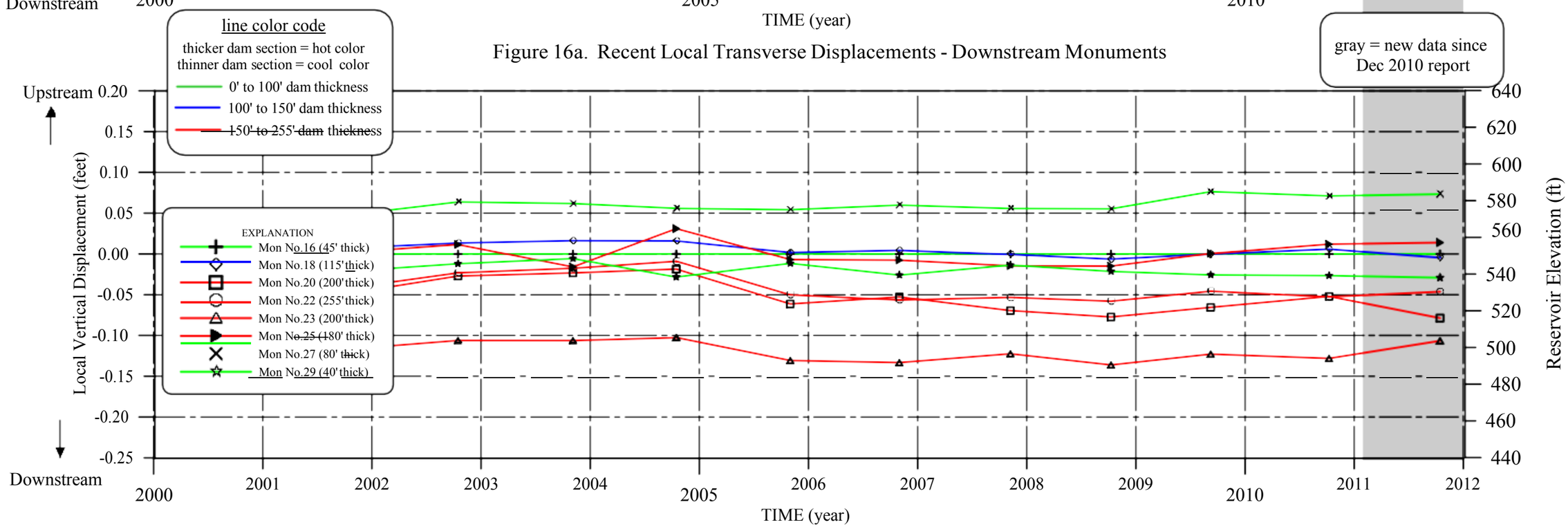

Figure 16b. Recent Local Transverse Displacements - Upstream Monuments

Notes:
1) File W:\Geology\DAMS\Annual Dam Safety Reports\FERC\Annual Reports\2010\survey\AndDS&UTransPlots-10.grf
2) Since the 2004 survey the District no longer shows changes in datums

Santa Clara Valley Water District

Recent Local Transverse Displacement
- Downstream and Upstream Crest Monuments
Leroy Anderson Dam

FIGURE
16

TABLE 4
Vertical and Local Transverse Data - Crest and Abutment Monuments
Leroy Anderson Dam

Date	Cumulative Monument Vertical Displacement (feet) (since 1988)														
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
10/8/2010	0.04	-0.02	-0.04	-0.24	-0.18	-0.33	-0.28	-0.21	-0.34	-0.16	-0.11	-0.04	0.02	0.04	0.05
10/14/2011	0.04	-0.03	-0.04	-0.24	-0.18	-0.33	-0.28	-0.21	-0.35	-0.17	-0.12	-0.04	0.02	0.04	0.05
change in disp.	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00
10/10 to 10/11	Average change since last survey =						0.00	or 0.0"							

Date	Cumulative Dam Crest Monument Local Transverse Displacement (feet) (since 1988)														
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
10/8/2010	0.00	-0.06	0.01	-0.14	-0.05	-0.19	-0.05	-0.13	-0.18	0.01	-0.05	0.07	-0.01	-0.03	0.00
10/14/2011	0.00	-0.05	0.00	-0.14	-0.08	-0.20	-0.05	-0.11	-0.19	0.01	-0.05	0.07	-0.02	-0.03	0.00
change in disp.	0.00	0.01	-0.01	0.00	-0.03	-0.01	0.00	0.02	-0.01	0.00	0.00	0.00	-0.01	0.00	0.00
10/10 to 10/11	Average change since last survey =						0.00	or 0.0"							

Notes:
1) Negative transverse displacement signifies downstream movement
2) Positive transverse displacement signifies upstream movement
3) Displacement is net displacement since 1988
4) NR = monument not surveyed (Mon. 31 destroyed during new boat ramp construction; Mon. 30 new control pt)
5) Local Transverse data shown back calculated to 1988 - see text
6) Mons #16 and 30 are control points and do not show local transverse displacement
file:W:\Geology\DAMS\Annual Dam Safety Reports\FERC\Annual Reports\2011\survey\ANDsurvey-11.xls

As shown in Figures 15 and 16, the time-series lines are color coded to generally depict the relative thickness of the embankment (depth from crest to foundation) directly beneath each monument on the vertical and transverse plots, where thicker dam sections are shown by hot colors and thinner sections are shown by cool colors. Red lines depict embankment thicknesses between ~150 feet and ~255 feet, blue is for embankment thicknesses between ~100 feet and 150 feet, and green is for embankment thicknesses between 0 feet and 100 feet. This gives a quick visual on whether monument movements are occurring on the more critical thicker sections relative to the less critical thinner sections of the dam.

The lines tend to group relative to color on Figures 15 and 16, with green lines (thinner section) generally plotting along the top, blue in the middle and red lines (thicker section) at the bottom of each plot. These trends indicate greater movements with time for thicker sections relative to thinner sections of the dam, which is typical for a large embankment dam with a significant differential in thicknesses. This appears to be generally true for both vertical and transverse displacements.

4.8.4 Monument Survey Data Gaps

There were no significant survey data gaps during the current reporting period.

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4.8.5 Spillway Training Wall Monuments

Three survey monuments are located at the top of the spillway training walls, two on a wall on the left side of the spillway ogee (Mons. Nos. 14 and 15), and one on a wall on the right side of the ogee (Mon. No. 13), as shown in Figure 1. Monument No. 13, on the right spillway wall, has not been monitored since October 2001. Previous spillway training wall horizontal and vertical survey results may be questionable due to access issues. Because of the difficulty of accessing the monuments positioned at the bottom of a chain link fence, some errors may be introduced in the survey data from the spillway training walls (see Nelson and Volpe, 2004 for more information). Even with these limitations, this surveillance report provides historic data plots showing vertical displacement of Monuments 14 and 15 in Figure 17.

4.8.6 Survey Data – Training Wall

During the period of this report, Dam crest Monuments No.14 and No. 15 are monitored and their locations are shown on Figure 1. The vertical data for the training walls presented in Figure 17, and summarized on Table 5. Net vertical and transverse displacements since the last surveillance report (i.e. from October 2010 to the October 2011) is shown at the bottom of each data set on Table 5.

Survey results of crest and abutment monuments indicate minimal horizontal and vertical displacements (less than 0.01 ft in the vertical plane) have occurred during this reporting period. These small displacements indicate that only minimal, normal displacements of the dam have occurred during this reporting period with no obvious trends.

TABLE 5
Vertical Displacement Data
Spillway Training Wall Monuments
Leroy Anderson Dam

Date		Monument Vertical Displacement (feet)		
		13	14	15
10/8/2010		NR	0.03	0.06
10/14/2011		NR	0.04	0.05
change in disp. 10/10 to 10/11		NR	0.01	-0.01

Avg. change since 10/10 = 0.00 or 0.12"

Notes:

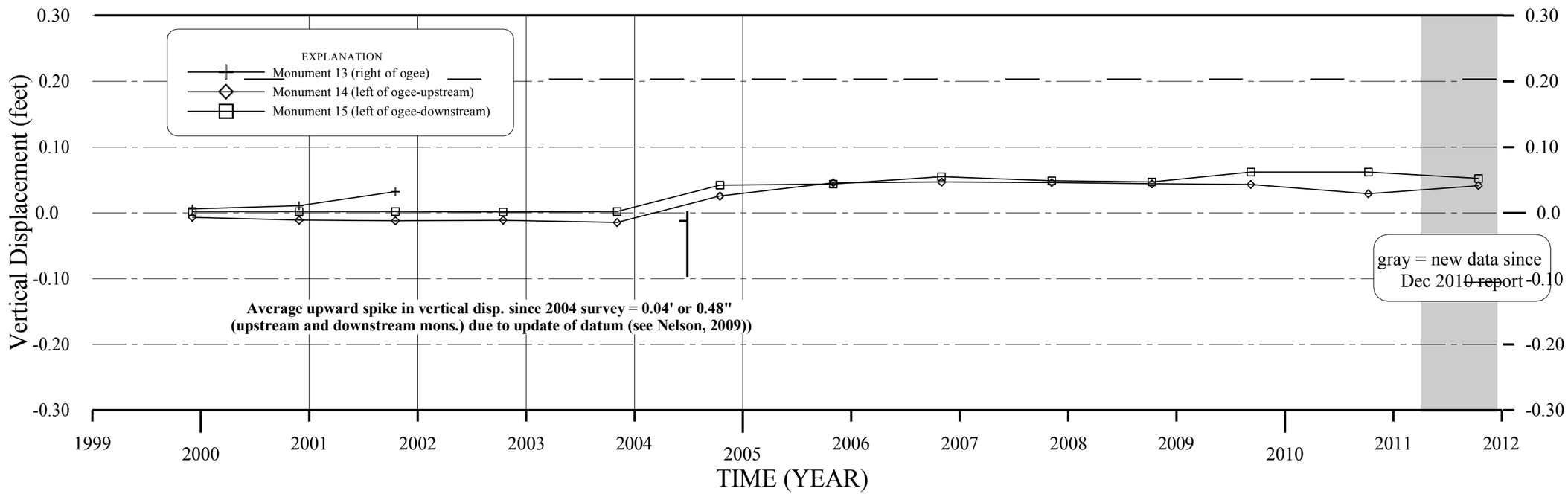
1) Negative vertical displacement represents settlement

2) Positive vertical displacement represents heave

3) file:W:\Geology\DAMS\Annual Dam Safety Reports\FERC\ Annual Reports\2011\survey\AndTranWallVert-11.xls

4.8.7 Spillway Training Wall Survey Data Gaps

There were no significant training wall survey data gaps during the current reporting period.



Notes:
1) Mon. 13 not surveyed since October 2001
2) File W:\geology\annual dam safety reports\DSOD\Anderson\annual reports\2011\survey\AndtrainWVert-11.grf
3) Since the 2004 survey the District no longer shows changes in datums

Santa Clara Valley Water District

Vertical Displacements - Spillway Training Walls

Leroy Anderson Dam

FIGURE
17

4.9 In-Place Inclinometer Sensors (IPIs)

Six Little Dipper bi-axial sensors known as in-place inclinometer (IPIs) are located in inclinometer boring IPI9-1 (boring 72-9-ASI-1) shown on Table 6 and in Figure 1 (plan view) and Figures 3 and 4 (section view). The purpose of the IPIs is to monitor gross internal movements of Leroy Anderson Dam such as those that could occur during a significant earthquake or rapid drawdown of the reservoir. In District surveillance reports, we use the following abbreviations to differentiate between the individual in-place inclinometer boring (IPI) and in-place inclinometer Little Dipper bi-axial sensors (IPIs).

For clarity we decided to renumber the original DIP designation IPI9-3 for inclinometer boring to the current designation of IPI9-1 and sensors to the current designations of IPIs 9-1 through 9-6.

4.9.1 IPIs Data

Table 6 summarizes pertinent information on each IPIs including IPIs designation, drill hole designation, sensor depth, sensor elevation, and surface elevation at the top of the inclinometer boring.

Table 6
Locations of In-place Inclinometer Sensors (IPIs)
Leroy Anderson Dam

Crest Inclinometer IPI9-1* (boring 72-9-AS1)				
IPIs Designation	**X-axis & Y-axis**	Spacing between sensors (ft)	Sensor Depth (ft)	Sensor Elev. (ft)
IPIs9-1	9-1X	36.5	36.5	610.5
	9-1Y	"	"	"
IPIs9-2	9-2X	21.5	58	589.0
	9-2Y	"	"	"
IPIs9-3	9-3X	21.5	79.5	567.5
	9-3Y	"	"	"
IPsI9-4	9-4X	21.5	101	546.0
	9-4Y	"	"	"
IPIs9-5	9-5X	21.5	122.5	524.5
	9-5Y	"	"	"
IPIs9-6	9-6X	51.5	174	473.0
	9-6Y	"	"	"

notes:
1) * = formerly designated as IPI9-3
2) sensor spacing includes length of fiberglass connector rod and length of senso
3) +Y axis is pointing upstream and +X axis is pointing to the left abutment
4) Boring surface elevation = 647 ft (at crest)
5) yellow shading = IPIs9-6 not functioning since 7/09

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4.9.2 In-Place Inclinometer Sensor Data

In an effort to aid review of surveillance data by condensing plots, Figure 18 is a compilation of X-axis and Y-axis data plots for all IPIs. Specifically, Figure 18 shows inclinometer readings versus depth (i.e. elevation of sensor). Plots of incremental X-axis and cumulative X-axis data are shown in Figures 18a and 8b, respectively. Plots of incremental Y-axis and cumulative Y-axis data are shown in Figures 18c and 18d, respectively.

Apparent minor deflections are evident on Figures 18a through 18d. An apparent deflection of ~0.4 inches is evident in IPIs 9-4 in the right abutment (negative X) direction and the downstream (negative Y) direction. An apparent deflection of ~0.4 inches is evident in IPIs9-2 in the right abutment (negative X) direction. It appears likely that these deflections indicate either 1) minor adjustments of the IPIs in the casing, 2) minor adjustments of the casing itself with time, or 3) normal variation in readings. The absence of progressively increasing deflections in IPIs9-1 through IPIs9-6 with time indicates that no obvious movements are occurring at depth in the vicinity of the crest. We will keep FERC apprised of any adverse trends in the IPIs data.

It is customary to assume that the bottoms of inclinometer borings are stable in order to calculate relative displacements upward along the entire length of the boring column. This is reasonable because the bottom of the inclinometer casing IPI9-1 is socketed into stable bedrock.

As noted in the 2010 report (Nelson, 2010), the bottom IPIs9-6 at elevation ~473 feet hasn't provided reliable readings since July 2009 (yellow shading in Table 6). The readings are obviously spurious because the manual readings do not stabilize (i.e. volt readings constantly drift). Although not considered reliable, we assumed that IPI9-6 was relatively stable (zero displacement) for calculating relative displacements. The intended design of the IPIs for the dam instrumentation program (DIP) at Anderson Dam was to place the bottom sensor at such a depth that it is relatively low within the embankment (i.e. surrounded by laterally continuous earth materials) and thus could essentially be considered stable. At elevation 473 the total lateral extent of the embankment (core plus shell) in the upstream/downstream direction is ~900 feet, with ~450 feet upstream and ~450 feet downstream. The District will replace IPIs9-6 if it continues to provide unreliable readings and will keep FERC apprised of this situation. Replacement sensors are currently available and can be installed during the next (2012) reporting period, if necessary.

4.9.3 IPIs Data Gaps

No significant gaps in the IPIs data are present during the current reporting period.

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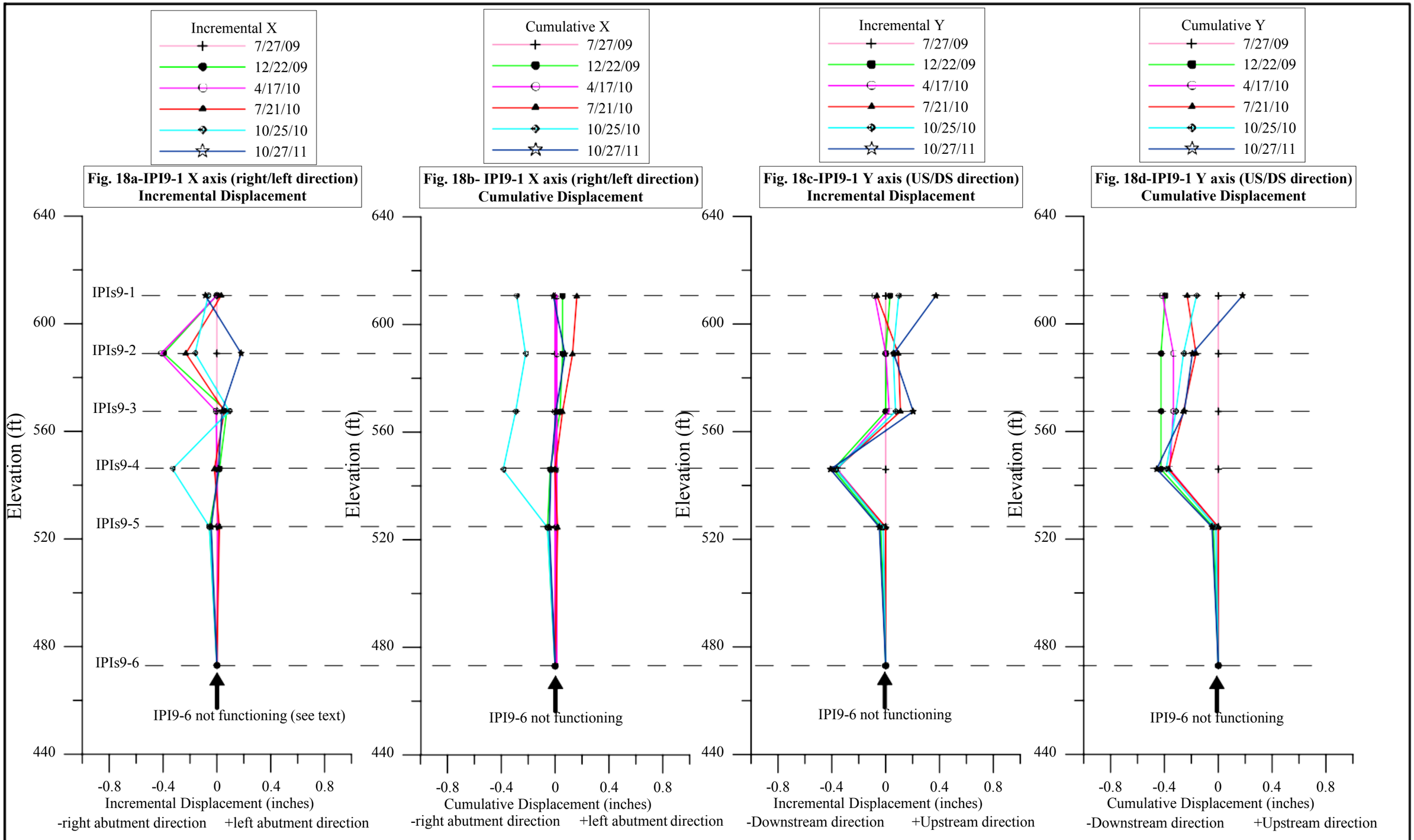

Notes:
1) Basis of elevations is NAVD 1988 - values on this plot are 2.89 feet higher than NGVD1928
2) File W:\Geology\DAMS\Annual Dam Safety Reports\DSOD\Annual Reports\2011\IPIs\AndIPIsX&Y.grf

Santa Clara Valley Water District

Recent In-Place Crest Inclinometer Sensor Data

Leroy Anderson Dam

FIGURE 18

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4.10 U.S.G.S. and District Strong Motion Accelerometers

4.10.1 U. S. Geological Survey Accelerometers

Seven Kinemetrics Model SMA-1 strong motion recorders (accelerometers) were installed in 1985 by the U.S. Geological Survey (U.S.G.S). Five accelerometers are installed on the downstream slope, one is situated about 150 feet south-southwest of the crest in the left abutment (see Figure 1), and one free field accelerometer is situated about 300 feet downstream of the toe of Anderson Dam. The accelerometers are operated and maintained by the U.S.G.S. District Dam Safety Program Unit personnel request seismic data from the U.S.G.S. if the seven instruments have recorded seismic accelerations after significant earthquakes occur in the vicinity of Anderson Dam.

During the current reporting period there are no accelerometer data to report.

4.10.2 District Accelerometer

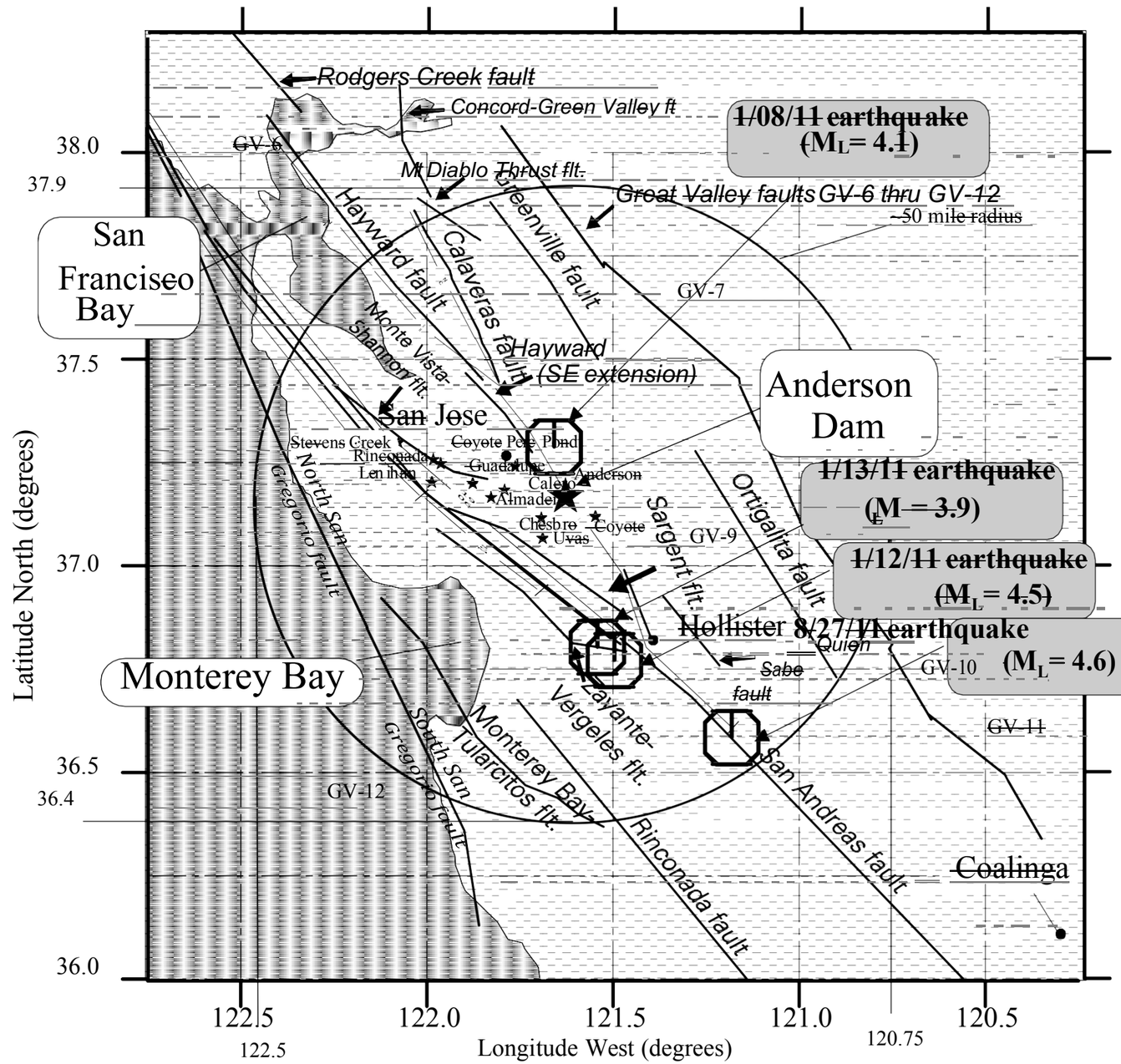
An Altus Etna strong motion accelerometer manufactured by Kinemetrics is securely mounted on the floor of the blockhouse on the crest of the dam. The purpose of the accelerometer is to record accelerations in the vicinity of the dam in the event of an earthquake. The accelerometer continuously monitors ground acceleration and compares current acceleration levels to preset thresholds. When an excursion of the threshold acceleration value is detected, ADAS notifies the District with an alarm that the threshold condition (typically 0.03 g) was exceeded. No alarms were triggered during the period of this report.

ADAS is set up to query the accelerometer for possible data at a 10-minute frequency during every 24 hour period. In addition, ADAS routinely retrieves data from VWPs and IPIs every 10 minutes. These frequent-interval data are temporarily stored in flash cards in the ADAS instrumentation center located onsite in the block house on the crest of Anderson Dam. These data are only retrieved manually by District Dam Safety Program personnel after they have been alerted to an alarm condition of the accelerometer. Data flash cards are retrieved from the dam and taken back to the office, where all pertinent ADAS data recorded at 10-minute intervals are then compiled and analyzed.

5.0 SIGNIFICANT AND NOTEWORTHY SEISMICITY

There were no earthquakes greater than M_L 5.0 during the reporting period from December 2010 through December 2011 within 50 miles of Anderson Dam. Significant earthquakes are defined as having approximate magnitudes greater than M_L 5.0. Noteworthy earthquakes, defined as having approximate magnitudes less than M_L 5.0 but greater than about 4.0 occurring within 50 miles of the dam, occurred at four locations in the San Francisco Bay Area, during the reporting period from December 2010 through December 2011 (Figure 19) with the following date, magnitude, distance and direction from Anderson Dam.

1. On January 8, 2011, M_L 4.1 earthquake, ~8 miles northwest
2. On January 12, 2011, M_L 4.5 earthquake, ~28 miles southeast
3. On January 13, 2011, M_L 3.9 earthquake, ~26 miles southeast
4. On August 27, 2011, M_L 4.6 earthquake, ~47 miles southeast



Explanation

Noteworthy earthquakes (see text)

District Dams

Fault segment abbrivations/ Probability of Magnitude 6.7 or greater occuring in next 30 years

NC = Northern Calaveras

CC = Central Calaveras

SC = Southern Calaveras/ 18%

PSSA = Peninsula Segment of the San Andreas/ 21%

SCM = Santa Cruz Mts.

1906 = 1906 EQ

NH = Northern Hayward/ 32%

SC = Southern Hayward

GV = Great Valley

Concord-Green Valley/ 6%

San Gregorio/ 10%

Mt. Diablo thrust fault/ 4%

Greenville/ 6%

N

0 20

Scale in Miles

Site Coordinates: Latitude: 37.165 N
Longitude: 121.629 W

Notes: 1) File W:\geology\dams\annual dam safety reports\FERC\2011\seis\Andseis-11.grf

DATE	11/21/11
DESIGN	JLN
DRAWN	JLN
CHECKED	DEH

Santa Clara Valley Water District

Regional Fault Map Showing Noteworthy Earthquakes

Leroy Anderson Dam

SCALE 1"=20'

FIGURE 19

6.0 VISUAL INSPECTIONS AND MAINTENANCE ISSUES

The following significant inspections were performed during the period of this report include:

1. February 14, 2011, semiannual inspection of Anderson Dam and appurtenant facilities by DSOD field engineers M. Sutcliff, and T. Jimenez with several District employees (D. Hook, B. Baker, S. Wu, J. Nelson, J. Sparkman, B. O'Mara, H. Gore, and R. Jacobs).
2. April 26, 2011, annual FERC inspection including five-year Part 12 inspection with District staff (D. Hook, R. Jacobs, M. Mooers, and J. Nelson), FERC Engineers E. Salire, W. Edwards, and R. Finucane, along with Part 12 consultants K. King, A. Niser, C. Hunt, C. Buckles, and W. Cole.
3. November 14, 2011, semiannual inspection of Anderson Dam and appurtenant facilities by DSOD field engineers P. Dhillon, and T. Jimenez with several District employees (D. Hook, S. Wu, J. Nelson, J. Sparkman, R. Jacobs, L. Fleming, and R. Ramento).

6.1 Other District Inspections

This section presents additional safety inspection by District staff focused on maintenance and monitoring issues. It should be noted that Dam Safety Program maintenance administrator Ron Jacobs inspects Leroy Anderson Dam monthly.

1. February 1, 2011, B. Baker and J. Nelson performed site visit to check non-functional ADAS and take manual readings of IPIs and VWPs 1, 2, 3, 4, 19, 20, 21, 22, 23, and 24.
2. February 16, 2011, District personnel (J. Nelson, M. Mooers, R. Jacobs, J. Sparkman, and B. O'Mara) met to discuss feasibility of dewatering the downstream foundation and toe of the dam by controlling the tailwater in Coyote Creek.
3. March 30, 2011, B. Baker, J. Nelson, and A. Partridge met at site to troubleshoot VWP power issues including replacement of batteries; also took manual readings of IPIs and VWPs.
4. May 12, 2011, District personnel (J. Nelson, M. Mooers, and R. Jacobs) met with AMEC engineer Marc Ryan to discuss feasibility of dewatering the downstream foundation and toe of the dam by controlling the tailwater in Coyote Creek.
5. June 1, 2011, District geologist B. Baker met with Roctest technician E. Constable to troubleshoot ADAS power issues; work included replacing batteries and modules, and cleaning corrosion from battery terminals.
6. October 20, 2011, J. Nelson and B. Baker performed site visit to retrieve ADAS data from on-site flash card and tested seismograph.

7.0 SURVEILLANCE PROGRAM

For the period of December 2010 to December 2011, no significant modifications of the dam or appurtenant structures occurred that would impact the surveillance data or its interpretation.

The District will continue with the current operating procedures and scheduled surveillance plans. Pneumatic and open well piezometers will be read monthly, crest and spillway training wall monuments will be surveyed annually, and spillway underdrain flows will be measured at the two weirs at least monthly. ADAS instrumentation (vibrating wire piezometers) will be read daily. In-place inclinometer sensors (IPIs) will again be collected with ADAS issues because power issues

were resolved in June 2011. In addition, site inspections and monument surveys will be conducted after a significant earthquake or other potentially disruptive activity.

Except for a new reservoir operating restriction of 45 feet (elev. 602.3, NAVD88), there are no substantive changes in dam or reservoir response compared to previous years. This operating restriction was implemented to provide an added margin of safety in response to preliminary seismic stability results for Anderson Dam. The 2011 restriction would be in place until the seismic retrofit of the dam is completed, which is currently anticipated to be the end of 2018.

8.0 OTHER INFORMATION

8.1 Recent Engineering Analyses

In June, 2011, AMEC (2011a) finalizing a detailed seismic safety evaluation (SSE1A) of Anderson Dam.

In August 2011, the District completed and submitted the 2011 (Sixth) Part 12D Safety Inspection Report for Anderson Dam (Geosyntec, 2011a) as required by the Federal Energy Regulatory Commission (FERC).

9.0 CONCLUSIONS

In 2011 AMEC completed the SSE1A investigation based on substantial geotechnical data and confirmed a potentially inadequate factor of seismic safety for Anderson Dam. In response to the findings of that report, the District implemented a voluntary operating restriction to ~elev. 602.3ft which is ~45 feet below the Dam crest. The new restriction supersedes the 2010 restriction of ~elev. 590.8 ft (NAVD88).

The surveillance data from Anderson Dam and the District's field observations confirm acceptable performance of the dam for the period of this report, with the dam showing normal responses to the environment, aging process, and external events. Except for a few instances during the period of this report when piezometer data excursions occurred outside of established action level limits for short periods of time, there were no surveillance instrumentation alarm conditions.

The District will continue with the current monitoring program and safety inspections, and will keep DSOD informed of any significant changes pertaining to the surveillance or performance of Leroy Anderson Dam.

10.0 SURVEILLANCE MONITORING REFERENCES

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GEI Consultants, Inc., 2009c, Leroy Anderson Dam FERC Part 12D Safety Review Amendment No. 1 to Agreement #A3094G Task 6.2, Foundation Rock Drain (RD) Investigation, dated March 23, 2008, 7 p.

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